OIL, GAS AND PETROCHEMICAL PROCESSING

Petroleum Refiner

FEBRUARY
1959

SPECIAL REPORT ON REFRIGERATION

Which Cycle Is Best? 109

Equipment Check List 115

How to Run Machines 123

ELECTRICAL TREND

Where Static Switching Is Headed 131

EASY METHOD

Predict Hydrogenation Equilibria 161

YOUR JOB

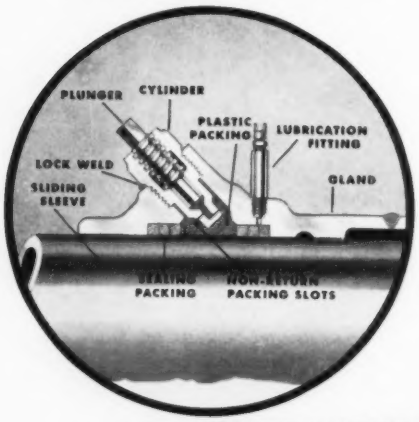
What Price for Professionalism? 193

For a "Quick Look" at this issue, turn the page . . .

SUBSCRIPTION PRICE $2 PER YEAR
SINGLE COPY PRICE 50 CENTS

new savings
for expansion joint users

Cross-section of Gun-Pakt feature. To add packing, just add a plug and turn the plunger. Note non-return packing slots at bottom of cylinder.



The Yarway Type W Gun-Pakt Expansion Joint has an improved one-piece design of body and gland and improved method of packing that provide new maintenance economies and greater operating efficiency.

Bolted joint between body and gland is eliminated; the steel body includes gland and guide. Shorter face-to-face dimensions are possible. Improved angle of packing guns makes them more accessible and *permits injection of the special plastic packing directly into packing space.*

The famous Yarway *Gun-Pakt* feature permits *addition of packing under full steam pressure. No need for costly shutdowns to repack.*

Sizes $1\frac{1}{2}$" to 30", pressures 150, 300, 400 psi. Single or double types, flanged or welding ends.

For full description, write for new Yarway Bulletin EJ-1916.

20" Yarway Type W Gun-Pakt Joint with base, single type, welding ends, 8 guns.

YARNALL-WARING COMPANY
128 Mermaid Avenue
Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY **GUN-PAKT**

...a good way to specify expansion joints

SINGLE COPY PRICE 50 CENTS

Volume 38, No. 2 February, 1959

Refrigeration Special Report 109

Which Refrigeration Cycle Is Best? 111
R. L. Huff

How to Select Refrigeration Equipment 115
James T. Robertson

How to Operate and Maintain Centrifugal Refrigeration Machines 123
Paul Ellard

OTHER TECHNICAL ARTICLES

What's the Future for Static Switching? 131
C. R. Olson and R. A. Ramey

Burner Design Gives More Uniform Heat 135
H. W. Morgan and R. J. Reed

Run Several Refineries the Best Way 139
George L. Landsly

Survey Reveals Lubricants Made 142

Chassis Grease—Going, Going, Gone? 143
W. M. Drout, Jr. and N. L. Jenkins

Shift to Area Maintenance Cuts Costs 147
Delmer G. Debo

Sulfur Is Removed Now by New Process 151
Robert J. Phillips and H. G. Napier

Quick Chart for Heat Transfer Rates 155
Frank L. Rubin

Heat Transfer Nomographs (Part V) 157
Jose Alvarez C. and Carlos Duhne

Know Your Insulations 159
Don Armstrong

Predict Hydrogenation Aromatics 161
A. Bondi

Taking Stock 164

As Management Sees It . . .

What Price Professionalism? 193
John J. McKetta

Safety Saves Insurance Dollars 200
K. C. Loomis

Footnote to Invention (How to Invent: Part VII) . 203
Forrest E. Gilmore

DEPARTMENTS

LOOK BOX, Featuring . . .
Ready for More Recognition? 13

Quick Look at Industry . . . 9
Mail Box 107
Valuable Reading Ahead . 166
How To Do It 168
Who's Building 174
What's Happening 207
Meetings Calendar 214
Men In Industry 216
Suppliers Notes 225
Reviewing New Books . . . 242
Classified Advertising . . . 242
New Equipment 244
Manufacturers Literature . 244
Index to Advertisers 258
Readers Service Card 257

PETROLEUM REFINER, published on the 12th day of each month. Second class postage paid at Houston, Texas.

Petroleum Refiner

OIL, GAS AND PETROCHEMICAL PROCESSING

©Gulf Publishing Company, 1959

A Quick Look

at This Issue

These handy digests permit checking ☑ the articles you want to read first.

REFRIGERATION SPECIAL REPORT

☐ **Which Refrigeration Cycle is Best? . . .** Of the two most popular refrigeration systems, vapor compression and absorption, which is optimum for your case? You'll find a comparison of the economics and efficiencies of each in this article. For investment and operating costs over wide operating ranges, turn to **Page 111.**

☐ **How to Select Refrigeration Equipment . . .** If you've ever wanted a rapid guide to help you to select process chilling equipment you now have it. Here is a straightforward set of suggestions to help you in this selection, turn to **Page 115.**

☐ **Centrifugal Refrigeration Machines . . .** Centrifugal compressors are the heart of modern vapor compression refrigeration units. You'll find a guide to proper maintenance and a trouble-shooting check list included in this article. For complete background and an informative short course, turn to **Page 123.**

☐ **What's the Future For Static Switching . . .** Metal-to-metal contact switching is becoming obsolete because of limited life, low-speed operation and arcing. The road is leading to magnetic, superconductor and electroradiative switching three new methods which look promising. To see how they work and where they can be applied, turn to **Page 131.**

Please Turn Page ➜

Photo courtesy Standard Oil Co. (New Jersey)

LOOKING FOR MORE HEAT

FROM THE FUEL YOU'RE NOW USING?

AN AIR PREHEATER CAN PUT AN EXTRA 1000° INTO YOUR FURNACE

You can get more heat – from the same amounts of your regular fuel – with a Ljungstrom® Air Preheater. An Air Preheater can recover as much as 1000°F from the exhaust of stills or boilers and return it to the combustion air of any kind of fuel-burning equipment. Extra furnace efficiency will in turn permit use of advanced boiler designs, finer controls and a more uniform, more profitable product.

You save fuel with preheated air, too. Even if you recover only 45°F from stack gas, you'll save 1% of your fuel bill. Recover 1000°F, and you can maintain present operating temperatures *on 20% less fuel.*

There's also less maintenance on a Ljungstrom-equipped furnace. Fuel burns more completely in preheated air, so there's less slag, fewer deposits, higher availability of equipment. What you save on maintenance and fuel alone will pay for your Air Preheater in two years or less. "Write-off" can be cut to *as little as nine months* if you use the extra capacity of a preheated furnace to boost product quality.

Free facts on fuel savings

One company's fuel savings with an Air Preheater are factually described in an article by Oliver F. Campbell. Write today for your free copy.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

A Quick Look at This Issue . . .

☐ **Burner Design Gives More Uniform Heat . . .** A flat flame burner gives more uniform heat in a direct-fired process heater. Here are the results of tests with this type of burner and some suggestions for controlling their operation. For more details, turn to **Page 135.**

☐ **Run Several Refineries the Best Way . . .** Linear Programing can tell you how to distribute crude between several refineries in order to achieve the greatest return. Look over this practical problem to see how you can apply this method to other scheduling situation. Turn to **Page 139.**

☐ **Chassis Grease—Going, Going, Gone? . . .** The permanently lubricated automobile appears to be due in three to five years. This downward trend in consumption of automotive grease can spell doom unless there are new grease developments on new markets. Keep pace with current and future trends by turning to **Page 143.**

☐ **Shift to Area Maintenance Cuts Cost . . .** A small refinery made this conversion in record time using some new organizational ideas. Maintenance costs were cut and a better operation obtained with fewer personnel. But there were problems which you'll read about along with a discussion of the advantages and disadvantages of area maintenance. For complete details turn to **Page 147.**

☐ **Sulfur Is Removed Now by New Process . . .** The first Electrostatic Desulfurization unit has just been placed in service at Cities Service's East Chicago refinery. Here is the first report of how it works on a reformer charge. Turn to **Page 151.**

☐ **Quick Chart for Heat Transfer Rates . . .** This chart gives factors for the Donohue equation used in finding heat transfer rates for fluids flowing across tubes in baffled heat exchangers. Especially adaptable to liquids, the chart gives answers in standard engineering units. Here's a real time-saver for your design notebook. Turn to **Page 155.**

☐ **Heat Transfer Nomograph . . . Part 5: Nusselt numbers for liquids and gases . . .** Functions in the heat transfer coefficient include an elusive factor called the Nusselt number. By using these two nomographs, you can quickly determine this factor. You'll find this valuable data for your design notebook by turning to **Page 157.**

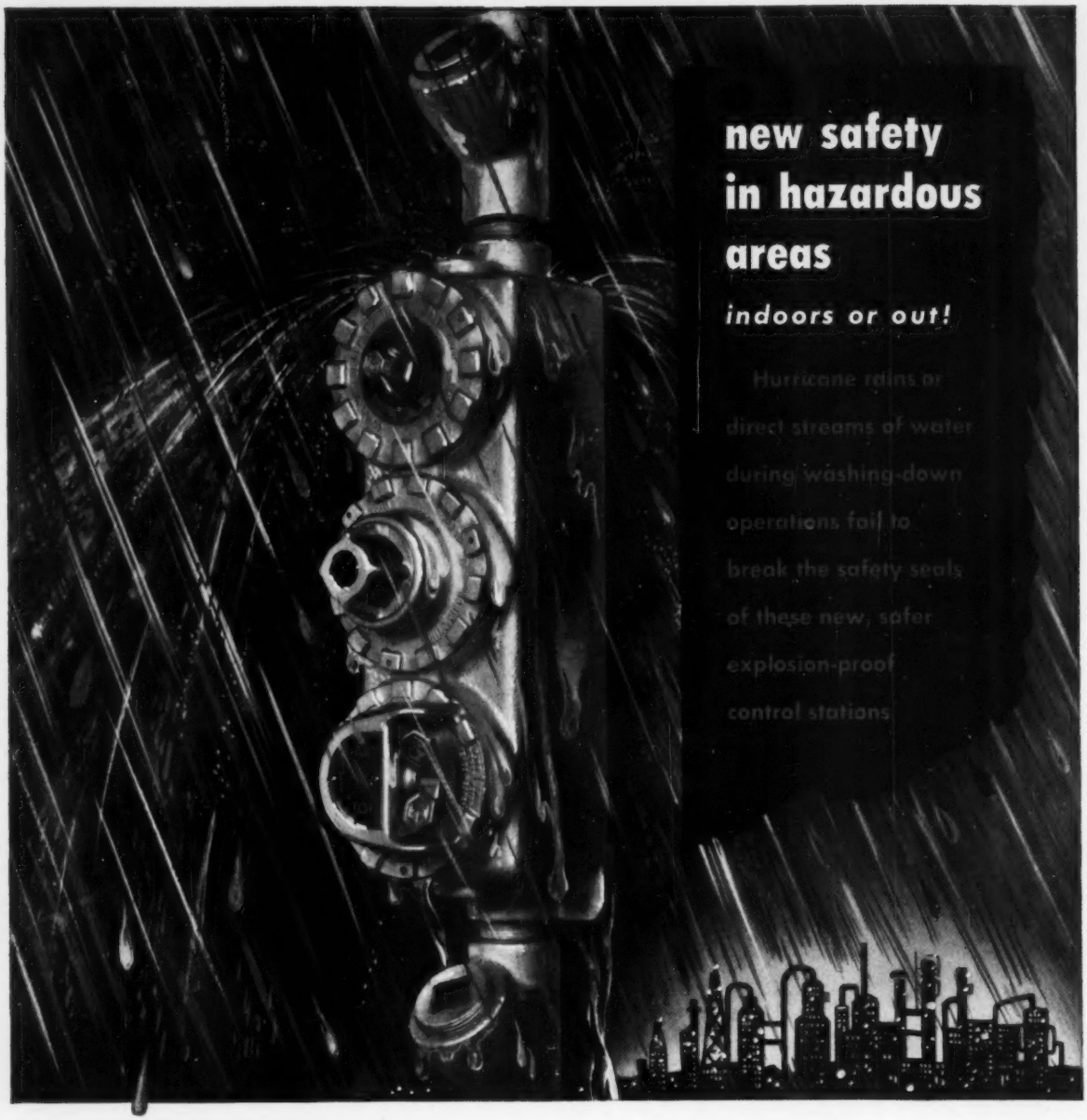
☐ **Know Your Insulations . . .** In order to specify the right insulation category for your job, you need to know the basic differences between various types. Here's a roundup of the varieties, their limits and range of usefulness. For complete details, turn to **Page 159.**

☐ **Predict Hydrogenation Equilibria . . .** Yes, there is a simple method of making this prediction and you can get fairly good results. Here is the method Shell Development is using with satisfactory results. It starts with some high powered long-haired physical chemistry but author Dr. A. Bondi brings it right back down to a working level for you. It's short, fast and easy. Look at **Page 161.**

☐ **What Price Professionalism? . . .** The same as the doctor or lawyer, the engineer is a truly professional man. But what must be done to achieve this professional status? At last here is an article which answers such questions as, can Professionalism help you in the future? What are the professional obligations? Must you be a professional? Is Professionalism your responsibility? You'll find the answers to these and many other questions when you turn to **Page 193.**

☐ **Safety Saves Insurance Dollars . . .** Every plant has to have fire and explosion insurance, but there are ways to keep the premiums to a minimum. For instance, by following the points in this article you can save more than $23,000 annually in insurance premiums. For the full story be sure to turn to **Page 200.**

☐ **Footnote to Invention . . . How to Invent: Part VII . . .** In this, the final article of this popular series, you'll learn how to develop a philosophy for inventing, how to sell or license your invention, how to start your own company, how to test your ingenuity quotient, and many other important items. Be sure to turn to **Page 203.**



NEW THREADED-JOINT NEOPRENE-SEALED

Control and Indicating Stations

Explosion-proof, dust-ignition-proof, weather resistant and water-tight (NEMA 4), this new Condulet® EWC series affords safety greater than ever before for pilot lights, heavy-duty push-button stations, selector switches, or various combinations thereof in single, double or triple gangs.

Designed expressly for Class I (Groups C and D) and Class II hazardous areas, the new series features a Feraloy® housing with *threaded* cover and *threaded* operating-shafts throughout. Cover, shaft housing and pilot light jewels are tightly sealed with Neoprene O-rings, effectively shutting out fumes, dusts, all water.

Write direct for descriptive literature and specifications, or contact your Crouse-Hinds distributor

CROUSE HINDS

MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK
Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.
Crouse-Hinds Instrument Company, Inc., Silver Spring, Maryland

● CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) ● FLOODLIGHTING
● TRAFFIC CONTROL SYSTEMS ● AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT ●

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington **Resident Representatives:** Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va.

For more data on advertised products, use Readers' Service Cards, last page.

Petroleum Refiner

RAY L. DUDLEY, Founder, 1891-1957

WILLIAM G. DUDLEY.....Publisher
TOM W. NELSON.....General Manager
R. M. DE SOMBRE.....Assistant General Manager
SILAS B. RAGSDALE.....Editorial Director
DR. JOHN J. MCKETTA, JR.....Chairman of Editorial Committee
GEORGE B. GIBBS.....Editor
FRANK L. EVANS, JR.....Maintenance and Design Editor
HAROLD L. HOFFMAN.....Process and Construction Editor
THOMAS C. PONDER.....Petrochemicals Editor
CLAYTON A. UMBACH, JR.....Management and Personnel Editor
HARRISON T. BRUNDAGE.....Eastern Editor
GILBERT M. WILSON.....Western Editor
DR. LEWIS F. HATCH.....Contributing Editor
WALLACE FITZGERALD.....Managing Editor
JACK COCKERHAM.....Presentation Editor
CHARLES VERVALIN.....Editorial Assistant
VAN WILLIAMS.....Editorial Assistant
EUNICE OKONESKI.....Librarian

ADVERTISING

Gene Hart, Advertising Sales Manager, Box 2608, Houston. *Representatives:* HOUSTON 19: Jack Walker, 3301 Buffalo Drive, Phone JA 9-4301; NEW YORK 17: George Skelton, Al Lucadamo, 250 Park Ave., Phone YU 6-6558; CLEVELAND 16: Harvey Dunn, 20800 Center Ridge Rd., Phone EDison 3-1650; CHICAGO 46: Martin Halloran, 6039 North Cicero Avenue, Phone AVenue 2-4333; LOS ANGELES: Jay Curts, Jim Merrill, W. W. Wilson Bldg., Huntington Park, Phone LUdlow 7-1219; TULSA 3: Jim Isaacks, 916 Enterprise Bldg., Phone CH 2-9211; DALLAS 2: Ed Thompson, 1808 Sylvan Drive, Phone RIverside 7-7344; EUROPEAN: Theodor Miocha, Agent, Limmerstrasse 31, Hannover, Germany, Phone 4-2935; UNITED KINGDOM: Frank Chambers, Agent, 120 Moorgate, London E.C.2, Phone Monarch 5661. Advertising rates on application. Cable Address: GULFPUBCO, Houston.

SUBSCRIPTIONS

F. G. Spindle, Subscription Manager, P. O. Box 2608, Houston 1, Texas, U.S.A. Single copies 50 cents (except special issues) for domestic and foreign. Double price for copies over one year old. Subscription rates—both foreign and domestic $2 a year. Subscriptions restricted to those engaged in oil, gas and petrochemical processing industries or service and supply company personnel connected thereto. Copyright 1959 by Gulf Publishing Company.

Postmaster: Send notification (Form 3579) regarding undeliverable magazine to Petroleum Refiner, Box 2608, Houston 1, Texas.

Specialized Oil Publications of
GULF PUBLISHING COMPANY
Box 2608, Houston (1), Texas

PETROLEUM REFINER and The REFINERY CATALOG for the oil, gas and petrochemical processing industry.

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry.

PIPE LINE INDUSTRY and The PIPE LINE COMPOSITE CATALOG for the oil and gas pipe line industry.

Petroleum Refiner is Indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, Ann Arbor, Michigan.

Magnetism of the $

THEY PREACH around our Editorial Offices that if you want almost certain readership, then use articles featuring the $ mark. And this is particularly valid if you can show how costs may be cut.

If that's the secret key, then our annual Maintenance issue, scheduled for March, is going to unlock the doors of a lot of readers.

Because Editor Frank Evans has lined up a dozen "How" articles and almost every one contains ideas that can mean real cost reductions in a plant maintenance program. No sacrifice of efficiency, either! Specifics:

- Use of multicraft mechanics, an idea that is being accepted by unions.
- How to ascertain the exact point in equipment life when it pays to replace rather than maintain equipment.
- Establish a precise, workable preventive maintenance program and how to know exactly *where* in your plant to start such a program.

Processing people, like many another, find the $ mark hard to resist; so we foresee heavy reader response to these three articles and their eight or nine companion pieces. Because our March Special Issue is branded with that significant sign almost from "kivver to kivver."

Centennially Speaking

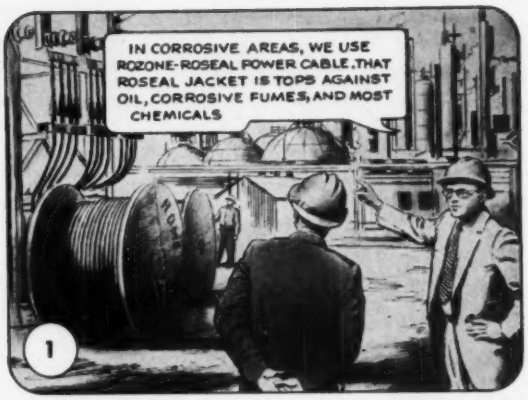
A MONTH AGO on this page we did not boast —nor, for that matter, even call attention to the Oil Centennial edition which was being issued. It wasn't because of a lack of pride but rather the thought that maybe you'd rather peruse and judge it objectively without benefit of tub-thumping.

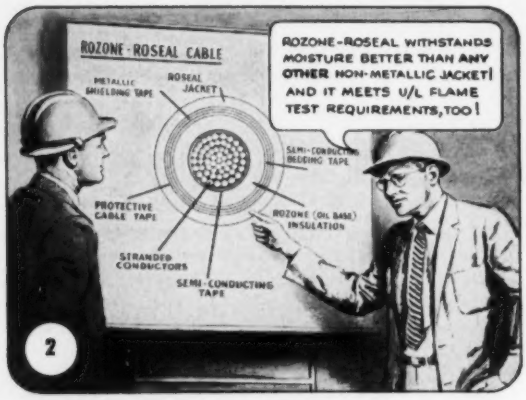
Good psychology or not, the results have been quite satisfactory. From front cover with its symbolic medallion in bronze on through the 66 pages of Oil Centennial material, PR readers seemed to have found good sound handling of material relating to this significant theme. It was not overdone as to bulk, and oil, gas and petrochemical processing historical facts were presented in a most attractive as well as authoritative manner. Also many found our look into the future most intriguing and valuable.

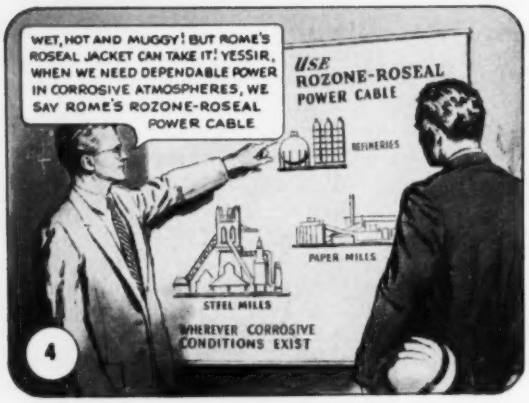
We predict that the January '59 issue will be used for years as a valuable reference and this is to suggest that if you're likely to need a spare copy, now is the time to get it in hand. It might well become, before too many years, a collector's item.

Requests continue to come in for PR's Author's Handbook. And we are always glad to send them out because we know something of the benefits which authors, particularly those who are not veterans in the craft, will derive from its pages. Others OK it, too. For instance John Kent, head of the Technical Writing Institute (third annual session scheduled soon on the West Coast) says, "Because the Author's Handbook is so complete and specific, I consider it *the best aid of this kind yet put out by any publisher.*" Want one?

DANGER! CORROSION AT WORK...


IN CORROSIVE AREAS, WE USE ROZONE-ROSEAL POWER CABLE. THAT ROSEAL JACKET IS TOPS AGAINST OIL, CORROSIVE FUMES, AND MOST CHEMICALS
1




WET, HOT AND MUGGY! BUT ROME'S ROSEAL JACKET CAN TAKE IT! YESSIR, WHEN WE NEED DEPENDABLE POWER IN CORROSIVE ATMOSPHERES, WE SAY ROME'S ROZONE-ROSEAL POWER CABLE
USE ROZONE-ROSEAL POWER CABLE
REFINERIES
PAPER MILLS
STEEL MILLS
WHEREVER CORROSIVE CONDITIONS EXIST
4

A matter of FACT

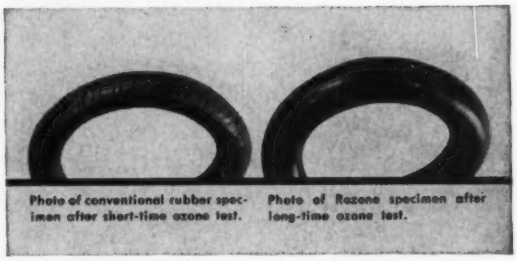


Photo of conventional rubber specimen after short-time ozone test. Photo of Rozone specimen after long-time ozone test.

Rozone insulation is high in dielectric and impulse strength and has excellent resistance to corona and ozone cutting.

Available in voltage ranges through 15 kv Rozone-Roseal preferred power cable may be installed in air, conduit, underground ducts, or directly in earth. Your choice of premium ozone-resistant insulations: Rozone (oil-base) or Rozone A (butyl-base). For complete information, contact your nearest Rome Cable representative and ask for Bulletin RCD-700. Or mail the coupon today.

ROME CABLE
CORPORATION

FREE BULLETIN describes the benefits of Rome's preferred high-voltage power cables.

ROME CABLE CORPORATION
Department 720, Rome, New York

Please send me a copy of the new Rome Cable Bulletin RCD-700.

Name .....

Title .....

Company .....

Address .....

.....

Type of business .....

Quick Look at Industry...

Wage Hikes Take 5% Pattern . . .

With few exceptions here and there, OCAW and independent unions are accepting 5% wage hikes. Break in wage freeze came with Sinclair's offer—thereafter, other companies began to thaw. Increase averages about 13.5¢ an hour—just slightly more than cost of living rise since last raise. This was disappointing for union negotiators.

"I recommended acceptance of the 5% settlement because I was fully convinced that it was all we could get without a long, costly and dangerous strike," said OCAW president Knight. "There was every indication that the Sinclair offer represented the united position of the entire oil industry," he added.

Latest Octane Postings . . .

To start off new year, octanes climbed higher in January. According to Ethyl survey, Premium rose 0.2 to reach 99.0 F-1 rating—new all-time high. Regular toed same mark it has for past three months, 91.5 F-1.

Synthetic Rubber Ratio Up . . .

U. S. demand ratio of synthetic to natural rubber jumped from 63.22% in '57 to 64.29% in '58 according to Rubber Manufacturers. But, total rubber demand last year fell 7.3% with synthetic down 5.7% and natural down 10%.

Petrochemical Propellent Market Growing . . .

Fluorocarbons, used as propellent in most aerosol packages, are growing rapidly. Today's capacity stands at 300 million pounds annually, but current estimates put 1960 propellent market alone at 120 million pounds.

Coal and Oil Form Research Team . . .

Two companies, Sohio Chemical and Consolidated Coal jointly researching methods of making hydrocarbon liquid fuels from coal. Expected to require 5 to 10 years before project can be evaluated for commercial possibilities. Work being done in jointly owned affiliate, Mountaineer Carbon Co., W. Va.

Gas Turbine Engine Closer . . .

With increasing horsepower, higher octanes, and costlier fuels, reciprocating engines may be less economical than gas turbines. Presently difficult to build 50-hp gas turbine engines to challenge reciprocating engine, but in 200 to 250-hp range, gas turbines rapidly become efficient enough to compete, authority claims.

Nitrogen Consumption Catching Up . . .

Serious over-capacity plaguing nitrogen producers should disappear by '61 recent survey claims. Since 1948 nitrogen consumption has increased 10% annually—should reach 4,176,000 tons by '61.

New Refinery Planned . . .

SoCal subsidiary, Petroleum Co. California, Ltd., studying feasibility of putting refinery in San Salvador. One attractive port: Acajutla. Could serve all Central America.

Solid Lubes at High Temperatures . . .

Above 1000 F, solid film lubricants still appear as only solution to high temperature friction and wear. In this range: aerodynamic heating, jet engine thrust controls, bleed air valves, variable pitch turbine blades. Lubricants are retarding development of high temperature designs—conventional liquid or grease lubricants aren't effective above 700 F.

Panning the Legislative Scene . . .

Rep. Van Zandt (R-Pa.) re-introduces bill for mandatory oil imports . . . Reps. Patman (D-Texas) and Roosevelt (D-Calif.) plan full hearings to ban oil producers from retail operations . . . Sen. Proxmire (D-Wis.) again pushing drive to cut oil and gas depletion rate . . . Rep. Lipscomb (R-Calif.) re-introduces bill granting fast tax write-off for smog treatment costs . . . Sen. O'Mahoney (D-Wyo.) authors bill requiring large companies to notify government 6 months in advance of price hike.

Refiners Hike Distillate Yield . . .

One refiner has upped distillate yield to 31% to meet increasing demand and attractive prices. However, industry average still far from maximum theoretical limit, 28.4%. Distillate and gasoline inventories would be in better position had this limit been approached. Many refiners increased crude runs to meet winter demands—thus aggravating high gasoline inventory (see also page 15).

Refinery Leasing at All-Time High . . .

Long-term leasing of operating equipment by refiners spurted to all-time high in '58. Dollar volume reached $19 million in December '58 as compared with $11 million in '57—gain of 72%. Oil refiners now rank among top 10 users of leased equipment.

Quick Look Around the Country . . .

Union Oil all but sews up land on Tulalip Indian reservation west of Marysville, Wash., for refinery site . . . Ike's new budget specifically asks Congress to hike federal gasoline tax from 3¢ to 4.5¢ a gallon . . . API plans some type of procedure to pay more attention to Russian technical developments . . .

Future Auto—Bigger or Smaller? . . .

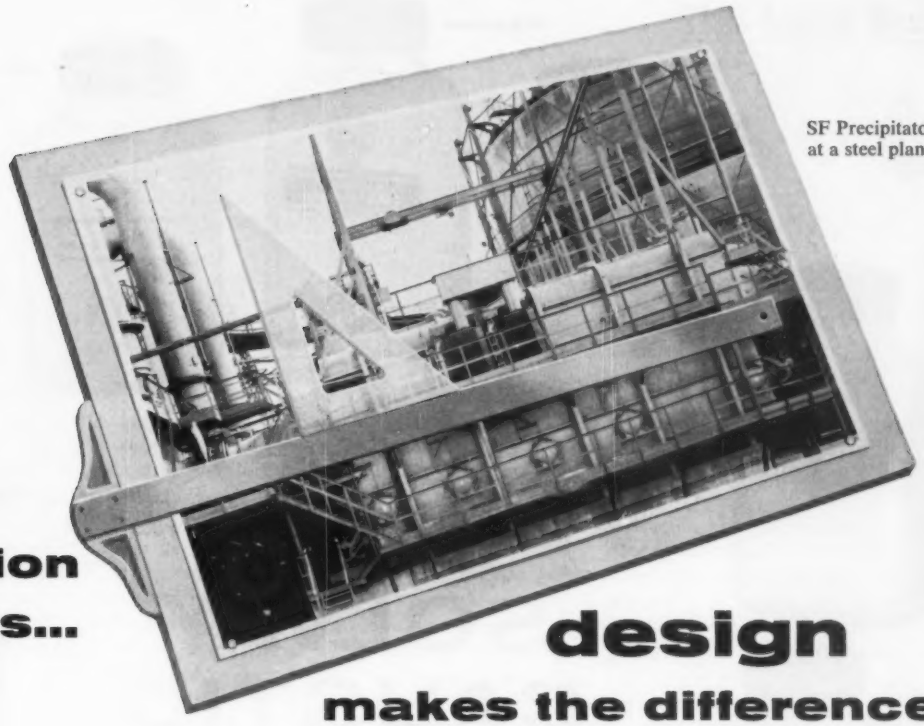
What will Detroit's future products be like? Increased production of bigger, more powerful cars now being countered by trend to smaller economy autos. These opposing forces may dictate wider spread of octanes for motor fuels. In past 2 years, spread has grown almost one-half an octane number—equal to more than 2% in power units. But—look for larger spread to come.

New Approach for LPG Engine Design . . .

Recent studies show new approach needed in design of engines using LPG. Result would be mechanical octane numbers gain. With present engines designed for gasoline, satisfactory knock-free operation with LPG is dependent on controlled carburetor air or mixture temperatures.

Refinery Barred—Ruled "Nuisance" . . .

Federal Court permanently restrained Commerce Oil from building $55 million refinery at Jamestown, R. I. Judge declared plant "nuisance" because of noxious odors and gases—said these would diminish property values.



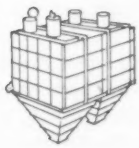
SF Precipitator at a steel plant.

In Dust Collection Systems... design makes the difference

Higher efficiency of Buell 'SF' Electric Precipitators is the result of exclusive engineering features. For example, Buell's *Spiralectrodes* emit 50% to 100% more electrons than other types . . . and *maintain* their efficiency. Positive gas flow control through adjustable baffles prevents scouring and eddying. And Buell's Unique Continuous Cycle Rapping practically eliminates "puffing".

BUELL CYCLONES

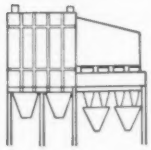
Lower installation cost of Buell's time-proved simplified design makes erection faster and easier. Spiralectrodes, for example, are self-tensioning, require no weights. Flexibility of power supply means easier installation, operating safety.



"SF" ELECTRIC PRECIPITATORS

Lower maintenance cost is the result of many details of superior design. And sectionalized design permits shutting down part of a unit without interrupting service in the rest of the unit.

Get full information: write for a copy of "Buell SF Electric Precipitators", a 22-page booklet. Write to Dept. 21-B, Buell Engineering Co., Inc., 123 William Street, New York 38, N. Y.



PRECIPITATOR-CYCLONE COMBINATIONS

buell®

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

9 forms to fit your needs in

SOLVAY CAUSTIC SODA

. . . and all include Solvay extra services

To help you use Solvay Caustic Soda most *efficiently*, we make 9 forms. To supply it *rapidly* and *dependably*, we produce it in 5 widely-scattered plants. To aid you in applying it most *effectively*, we provide technical service and literature based on extensive field work with users and painstaking laboratory research.

Sodium Nitrite • Calcium Chloride • Chlorine • Caustic Soda • Caustic Potash • Chloroform • Potassium Carbonate • Sodium Bicarbonate • Vinyl Chloride • Methyl Chloride • Ammonium Chloride • Methylene Chloride • Monochlorobenzene • Soda Ash • Para-dichlorobenzene • Ortho-dichlorobenzene • Carbon Tetrachloride • Ammonium Bicarbonate • Snowflake® Crystals • Aluminum Chloride • Cleaning Compounds • Hydrogen Peroxide
Mutual Chromium Chemicals

Allied Chemical

SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N. Y.

SOLVAY dealers and branch offices are located in major centers from coast to coast.

SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N. Y.

Please send without cost Solvay Caustic Soda sample or samples and literature as follows:

☐ 76% powdered ☐ 76% solid ☐ 76% ground ☐ 76% flake
☐ 76% small flake ☐ 50% liquor ☐ 73% liquor ☐ 50% mercury cell liquor ☐ 73% mercury cell liquor
☐ Technical Bulletin No. 6, "Caustic Soda"
☐ Wall chart of handling precautions

Name_____

Position_____

Company_____

Phone_____

Address_____

City_____ Zone_____ State_____

BF-19

Ready for More Recognition?

"THE CHEMICAL ENGINEER of the future will make more use of science than he has in the past. As he does, he will receive even greater recognition. He will play an important part in the long-range planning of his organization. He will be called upon to cooperate more closely with the research departments and will exert an influence in the early stages of a research project which will result in a process that lends itself to more efficient design.

"Management, on the other hand, will be more eager to inform the engineer of its future plans for expansion sufficiently well in advance so that there will be more time for study of alternatives and selecting sound design. Undoubtedly there will be shortages of engineering talent—particularly men of maturity with breadth of experience—but perhaps we have ourselves to blame to some extent for this shortage for often we have made it more attractive financially and otherwise for an engineer to become an administrator rather than to remain an engineer."

Dr. Charles Thomas, President of Monsanto Chemical Company, in addressing these words to the annual meeting of the AIChE, could have directed these thoughts to all engineers. And though he had in mind those men who are responsible for designing capital additions, his thoughts also apply to engineers in other functions. At the same time, the engineer needs to ask himself some soul-searching questions.

"Fundamental" Requirements. *Are you ready with fundamentals?* One of the things that systems engineering and computer controls has taught us is that we must return to fundamental methods for solving mass transfer, reaction kinetics, fluid dynamics and heat transfer problems. Empirical methods, developed over the years, have become second nature with many experienced engineers; but their application in computers must be waived for fundamental methods. This means you must brush up on what you learned in school or the young engineer will surely pass you up.

The trend toward automation has also forced us to return to the lab to fill in the voids of our understanding of the reactions. It's alarming but stimulating to realize that our present plants were based on inadequate knowledge.

Looking further, these trends mean that engineers who succeed will be men who accept special training. Monsanto, for example, is now operating an extensive program for training engineers in these special fields. And, of course, in addition to skill, these new methods will still require sound judgment.

Economic Knowledge. *Are you ready to accept economic responsibility?* Management will be sharing more economic information with engineers. You will have a unique and important part in the control of capital expenditures, as decisions on design will determine the money to be invested. The efficient use of capital, more than ever, is the difference between success and failure in our industry.

If this new responsibility is accepted, then there will be more recognition for engineers and as much incentive financially to remain an engineer as to become an administrator.

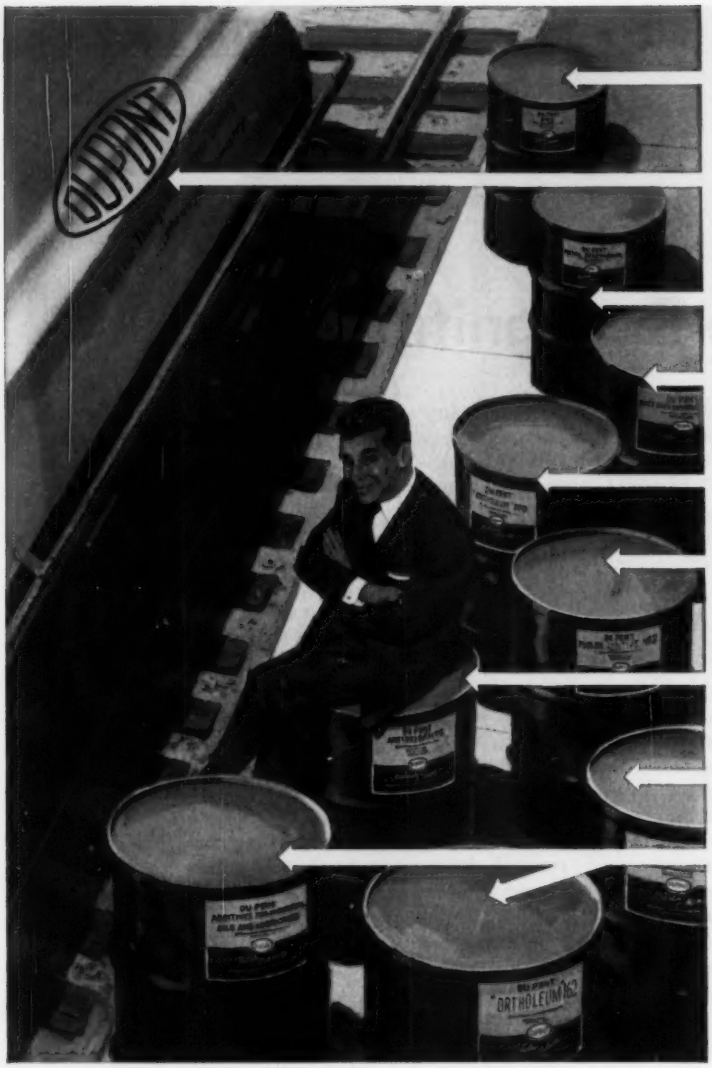
This new concept has already been extended to research departments by the creation of research associates. They have little administrative responsibility but carry equal prestige and salary as those who do.

Are you ready to accept the new competition? The industry is headed for one of the greatest competitive climates ever known. True, there will be an increasing demand for chemicals and plastics but satisfactory profits will go only to the low cost producer. The new climate will be quite different from the last ten years, when there was a wild rush to build new plants or enlarge old ones to meet the staggering demand.

Plants built during World War II or the Korean War carried 100 percent or partial certificates of necessity. This also accented the need to get onstream quickly and start the payout.

Also, we've seen companies, not in the processing business before, enter it with excess cash or credit. They were spurred on by the ready availability of processes, know-how and turn-key plants at a price less than the development cost.

A Trend to Watch. Traditional suppliers of raw materials and the old intermediate products, customers have entered the manufacturing field in competition with the chemical industry. To have a larger divisor for a lower unit cost, these plants were built for optimum capacity. Since this is greater than the immediate needs of the builder, excess production was offered on the open market. Thus today, the industry's capacity to produce many products is more than customers can consume. Integration by these companies, both forward and backward, is a con-



Du Pont Dyes—Du Pont offers a complete line of oil colors for identifying grades, meeting legal requirements and for adding brand identification to your gasoline, fuel oil, lubricants and other petroleum products.

Tetraethyl Lead—For smooth, knock-free power . . . highest octanes at lowest cost. To give you fast, dependable delivery, Du Pont maintains ample stocks at 25 distribution points throughout the U.S., convenient to refiners everywhere. Stocks are available in tank cars and drums.

Du Pont Metal Deactivator—Combat copper-caused gum in gasolines and sludge and gel formation in fuel oils with Du Pont Metal Deactivator (DMD). The industry's standard for nearly 20 years.

Du Pont Rust Preventive No. 2—Impart detergent action, stall protection and anti-rust property to gasolines at extremely low cost with Du Pont Rust Preventive No. 2 (RP-2). This superior product is widely used also in jet and heating fuels.

"Ortholeum"® 300—Stabilize and protect greases with "Ortholeum" 300 grease stabilizer. It offers the combined advantages of metal deactivation and antioxidant action.

Fuel Oil Additive No. 2—Improve your fuel oils with Du Pont FOA-2, the additive which stabilizes heating oils, diesel fuels and residual stocks. Its solubilizing action and dispersancy prevent sludge formation and suspend any sludge present in fuel systems. The sludge burns with the fuel.

Antioxidants—Protect gasolines from oxidation and gum formation. Complete line offers antioxidants for every purpose, every refinery stock. Du Pont Antioxidant No. 22 is especially noteworthy for its additional usefulness in sweetening.

Du Pont Metal Suppressor—A newly developed product uniquely effective for coating copper parts in hydrocarbon systems and thus suppressing solution of the metal into the product.

Additives for industrial oils and lubricants—Three widely used and highly effective additives for improving the performance and stability of industrial oils and lubricants are:

"Ortholeum" 162 lubricant assistant
PAN (phenyl-alpha-naphthylamine)
PBN (phenyl-beta-naphthylamine)

How Du Pont additives can help improve petroleum products

Each of the additives in Du Pont's complete line was developed to overcome a precise problem or add a performance "extra" to your petroleum product.

Service also is available for the selection and handling of these additives, and in training your blending plant personnel. Your Du Pont Petroleum Chemicals representative supplies these and many other services. He's backed by a large staff of specialists in research, training, production, safety, sales promotion and advertising, men who have devoted long careers to cooperating with refiners.

Feel free to call in your Du Pont representative, or write Petroleum Chemicals Division, E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Delaware.

DU PONT

Better Things for Better Living . . . through Chemistry

Tetraethyl Lead and other Petroleum Additives

For more data on advertised products, use Readers' Service Cards, last page.

tinued trend to be reckoned with.

What's more there's new competition from overseas. Many European chemical plants were bombed out during the war. While out of commission, U. S. production in increasing amounts went overseas. Now these plants have been rebuilt, based on the newest and most economical processes. These goods in some cases can be exported to the U. S. at prices under ours.

If you can answer "yes" to these questions, you're in for a bright future.

Increased Distillate Yields

IT IS THAT TIME of the year when the smart refiner is increasing distillate yield as a means to meet distillate demand and yet not build up gasoline stocks. The past December was 38 percent colder than the previous December. Distillate prices have risen 5.8 percent above last year.

Refiners have reduced distillate inventories and increased runs to meet the demand. But increasing runs carries the disadvantage of increasing gasoline inventories, not justified in the present gasoline picture. The best approach is to maximize distillate yield while cutting down on gasoline.

As reported by Humble Oil & Refinery Company's Harry Ferguson at the annual API meeting, refiners still have a long way to go before reaching the theoretical maximum yield of distillate (28.4 percent versus an average 22 percent). It can be calculated that had refiners maximized distillate production and minimized gasoline production during last six weeks, it would have been possible to turn out 11.7 million barrels more distillate while reducing gasoline output by 22.1 million barrels. Thus, there would now be a better balanced position between gasoline and distillate inventories.

The maximum theoretical distillate yield assumes average crude with average equipment. With more favorable crude and equipment, one refiner is now operating at 31 percent distillate yield. This should mean more profit and a firmer market.

Where Would We Be?

ADVERTISING PEOPLE and media have just completed a united campaign to remind all Americans of the benefits which advertising brings to them in the form of more jobs, better products and lower prices. This joint effort was quarterbacked by the Advertising Federation of America and the Advertising Association of the West.

Theme of the whole plan was "Advertising Works for You"—and it certainly does!

Consider for a moment the ads you will see as you turn the pages of this particular issue of PETROLEUM REFINER. Won't they bring you important information on new and better products, on new processes and new methods? Won't they give you ideas for improving production and trimming costs? Won't they help you keep pace with a rapidly-expanding economy so that you and your organization can grow and thus provide more jobs? The answer to each, of course, is a positive "yes." Many of the ads following this page will do all of those things.

But consider for a moment, the picture from the other side of the fence. Your company probably has an advertising program, and it is doing the same thing for others.

That's why we ask you to pause for just a moment and reflect on the importance advertising plays in each of our lives. How else would business firms be able to inform people all over the world of their products and thus achieve mass distribution? And just where would we be without it?

Much Research Even in '58

INDUSTRIAL PROGRESS —in fact, the very life of industry itself, is bound inextricably with and to competitive-research and development effort.

And this is one of the silver linings of this period which we call "the recession." Because during the recession and, of course, in spite of it, industry's investment in research activities in 1958 reached about $9 billion. This figure recently was termed by James M. Flounders of the B. F. Goodrich organization as "the highest level in history and 10 percent above last year's record."

Coming as it did "during an economy-minded year that saw substantial curtailment in capital expenditures elsewhere in industry," this is indeed a bright spot in what many are forced to call a drab year.

Much of the payoff on such a huge expenditure may still be around the corner. In our November issue we quoted another leading industrialist as saying that "the chemical industry people have a saying, 'Seven years from test tube to tank car.'" Yet the American industrialist, generally, is a pretty hard-headed business man not inclined to throw money away. So even though "the results of their work will not be known for two, three, five or seven years," as Mr. Flounders confirms, they can look back and see, as he also points out, that "technical improvements are coming so rapidly that many companies now derive the major portion of their sales revenue from products that did not exist ten years ago."

So deciding that there is perhaps no gage more accurate than actual experience, U.S. companies chipped into a pot that aggregated $9 billion in a single year.

This is not to say that a more effective program of research nor of its use is impossible. Best source of new ideas for new products, according to Mr. Flounders, is an engineering working arrangement between a manufacturer and a customer who has a problem. We concur in his recommendation that "customers' engineers co-operate with their supplier by stating problems in a concise manner and by providing thorough evaluation of new products furnished by the supplier." Certainly this is not too much to shoot for.

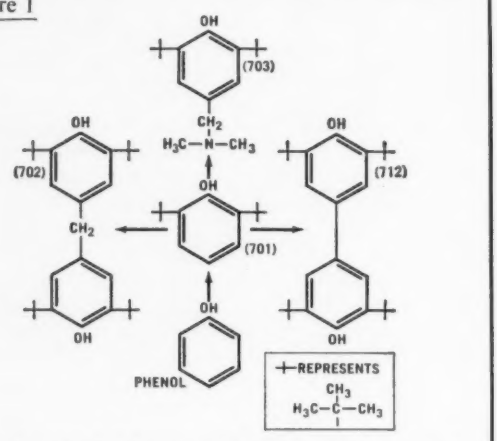
Discovery of "Ortho-Alkylation" reaction makes possible a new series of antioxidants for petroleum and petrochemical products

ETHYL'S DISCOVERY of the "ortho-alkylation" reaction has made available commercially, for the first time, a whole new series of phenol and aniline derivatives alkylated in the two and six positions.

All of these compounds are excellent chemical "building blocks" because of the open reactive para position on the benzene ring. (Figure 1)

Exhaustive evaluation has shown that many of these compounds have superior antioxidant characteristics in specific petroleum product applications.

Figure 1



Phenol and iso-butylene are combined by Ethyl's patented "ortho-alkylation" process to form 2,6-di-*tert*-butylphenol (701). This compound, with the open reactive para position, is a chemical "building block" for other important additives.

"Ethyl" Antioxidant 701— A Gasoline and Jet Fuel Additive

One of these compounds, 2,6-di-*tert*-butylphenol, is an excellent gasoline and jet fuel additive for inhibiting the formation of gum and other oxidation products. This compound is available commercially as "Ethyl" Antioxidant 701 and in a more economical form as "Ethyl" Antioxidant 733.

The importance of 2,6-di-*tert*-butylphenol is increased by the fact that its derivatives contain the hindered phenol structure which is characteristic of effective phenolic antioxidants. This led Ethyl Research in the direction of many possible additives.

701 Also an Intermediate to Other Additives

Early work showed that a highly effective structure pointed to a compound in which the two and six positions were occupied by *tert*-butyl groups. The four position was then used to test substituents in experiments designed to modify the 2,6-di-*tert*-butylphenol structure in order to obtain improved antioxidants.

"Ethyl" Antioxidant 702. A Lubricant Antioxidant and Anti-Wear Agent

Lubricant applications involve elevated temperatures and aeration and thus it was desirable to examine structures having minimum vapor pressures. This suggested compounds with higher molecular weights that still retained desirable antioxidant properties.

One important additive resulting from this work is 4,4'-Methylenebis (2,6-di-*tert*-butylphenol) ("Ethyl" Antioxidant 702), an exceptional lubricant antioxidant. It is a low volatility, non-sludging, temperature-stable, phenolic antioxidant and anti-wear agent.

Numerous laboratory and field tests were used in examining the characteristics of "Ethyl" Antioxidant 702:

Antioxidant Evaluations

ASTM Steam-Turbine Oil Tests • Panel Coking Tests • Automatic Transmission Tests • CRC L-4 Tests • Modified Polyveriform Tests • EMD Silver Corrosion Test

Anti-Wear Evaluations

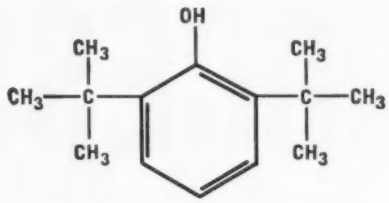
CRC L-4 Tests • Chevrolet "Full-Throttle" Tests • "Hot-Ring" Tests • CRC FL-2 Tests

"Ethyl" Antioxidant 702 has found application in crankcase oils for gasoline and diesel engines. Both oxidation and bearing corrosion are inhibited (Figure 2) and scuffing-type piston ring wear is minimized.

The compound is finding increased use in railroad diesel engine oils and in other applications where copper, silver and bronze parts are critical. In all evaluations, oil treated with "Ethyl" Antioxidant 702 showed outstanding improvement.

For more data on advertised products, use Readers' Service Cards, last page.

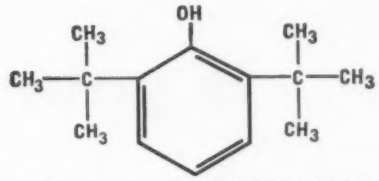
701—2,6-Di-*tert*-butylphenol



In motor and aviation gasoline to inhibit oxidation during storage; in jet fuels to inhibit oxidation during storage; and in industrial oils to inhibit oxidation.

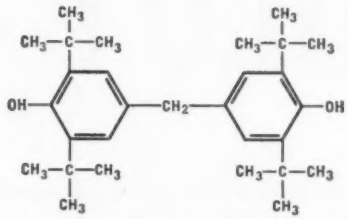
733—2,6-Di-*tert*-butylphenol (75% min) 2,4,6-Tri-*tert*-butylphenol (10-15%) Ortho-*tert*-butylphenol (10-15%)

(75% Min.)



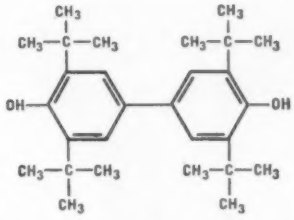
In motor and aviation gasoline to inhibit oxidation during storage; in jet fuels to inhibit oxidation during storage; and in industrial oils to inhibit oxidation.

702—4,4'- Methylenebis (2,6-di-*tert*-butylphenol)



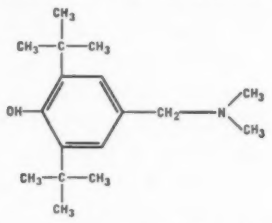
In motor oils for both gasoline and diesel engines to inhibit oxidation and minimize scuffing-type piston ring wear; in automotive transmission fluids and industrial oils to inhibit oxidation; and in plastics and rubbers to inhibit oxidation.

712—4,4'-Bis (2,6-di-*tert*-butylphenol)



In petroleum-based oils for high-output engines to inhibit oxidation and minimize scuffing-type piston ring wear; in diester-type synthetic oils to control oxidation and deposit formation; and in plastics and rubber to inhibit oxidation.

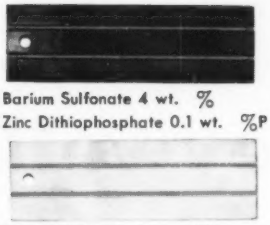
703—2,6-Di-*tert*-butyl-α-dimethylamino-p-cresol



In motor oils, greases and industrial oils to inhibit oxidation and impart alkylinity, dispersancy, anti-rust and anti-wear properties; in diester-type synthetic oils to inhibit oxidation during storage.

EMD SILVER CORROSION TEST

Silver coupons from railroad diesel engine oil test at 275°F. for 72 hours.



Barium Sulfonate 4 wt. %
Zinc Dithiophosphate 0.1 wt. %P

Barium Sulfonate 4 wt. %
"Ethyl" Antioxidant 702 0.7 wt. %

Figure 2

How Ethyl Research is helping you

Ethyl Research Laboratories are searching continuously for new and better additives for the petroleum industry.

The discovery of the "ortho-alkylation" reaction opened a new field of investigation. As a result, several excellent antioxidants are now available for a wide range of petroleum and petrochemical products.

Fact sheets are available through your Ethyl Representative, or by writing Ethyl Corporation, 100 Park Avenue, New York 17, N. Y.

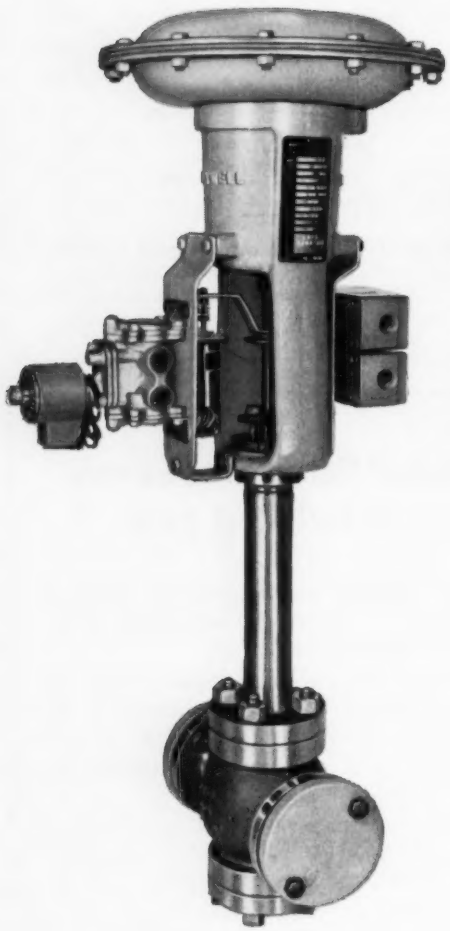
ETHYL CORPORATION
NEW YORK 17, N. Y.

ETHYL ANTIKNOCK COMPOUND — ETHYL CORPORATION

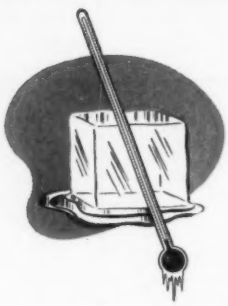
RESEARCH LABORATORIES:
1600 W. Eight Mile Road, Ferndale 20, Mich.
2600 Cajon Road, San Bernardino, Calif.

For more data on advertised products, use Readers' Service Cards, last page.

is your PROCESS FLOW COLD?



Honeywell control valves are available for a wide range of temperatures



Whether you're concerned with minus 450 or 1200°F, there's a Honeywell automatic control valve for your process flow. The Honeywell valve illustrated—Series 800, Type 12 single seated—is designed for liquid oxygen service. Thoroughly degreased and sealed, it includes such features as: bronze bushings . . . stainless steel body and trim . . . seal-welded seat ring . . . low-temperature bolting . . . non-lubricated, Teflon-impregnated, blue asbestos packing . . . designed clearances for non-sticking, non-galling operation.

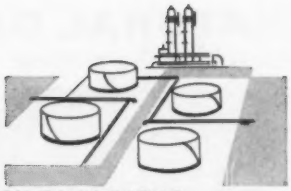
For hot or cold flows . . . or other process flow conditions . . . Honeywell valves are available in a wide range of types and sizes. When you need control valves . . . contact your local Honeywell field engineer. Write for new Catalog C800-1.

MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.

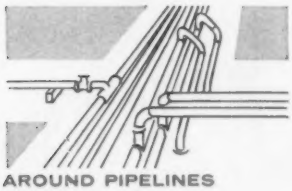
Honeywell

H HONEYWELL *First in Control*

For more data on advertised products, use Readers' Service Cards, last page.



ON TANK FARMS



AROUND PIPELINES

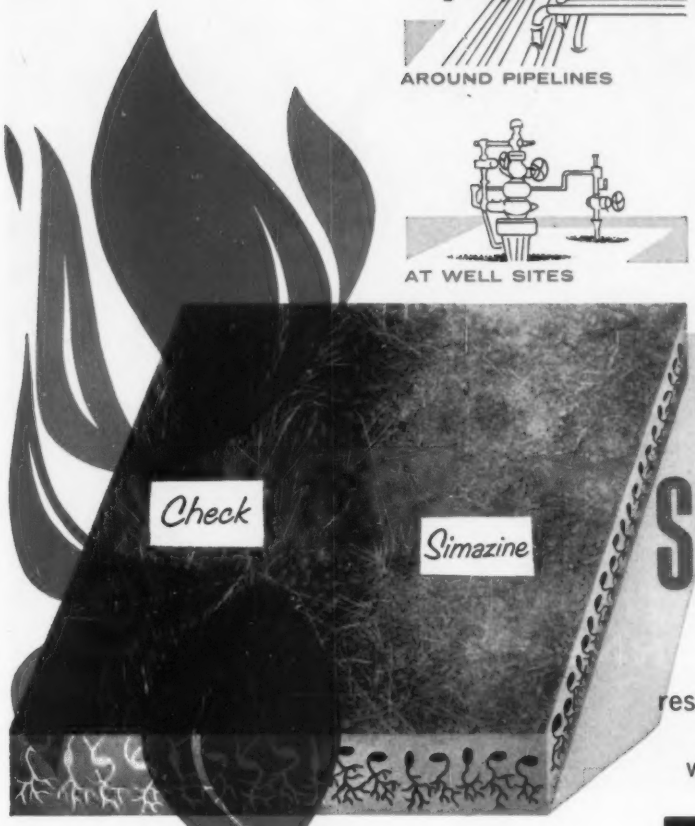
AT WELL SITES

stop weeds and fires before they start

get preventive weed control with

GEIGY SIMAZINE* 50W

pre-emergence residual herbicide with



7 SAFETY FEATURES

1. **SAFETY TO HUMANS AND ANIMALS**
   Extremely low toxicity. No need for protective clothing.
2. **SAFETY TO ADJACENT VEGETATION**
   Minimum lateral leaching. Remains where it is applied.
3. **SAFETY TO SPRAYING EQUIPMENT**
   Non-corrosive or abrasive to equipment.
4. **SAFETY NEAR ELECTRICITY**
   Relatively low electrical conductivity.
5. **SAFETY FROM DRIFT HAZARD**
   Works through roots—little or no toxicity to foliage.
6. **SAFETY FROM FIRE HAZARD**
   Non-flammable. No application hazard.
7. **SAFETY ON VALUABLE LAND**
   Not a permanent soil sterilant.

ORIGINATORS OF Geigy DDT INSECTICIDES

Weed control is an old problem to the petroleum industry. Now Geigy's pre-emergence herbicide Simazine 50W provides a new and better solution – makes weed control *easier* because it is long residual; *safer* because of its Seven Safety Features; and *more effective* because it stops weeds before they start.

ONE APPLICATION PER SEASON

At the rate of 20 lbs. per acre, one pre-emergence application of Simazine 50W controls most annual broadleaf weeds and grasses for an entire season. For longer residual control, or for control of more resistant perennials, use 30 to 40 lbs. per acre.

SEVEN SAFETY FEATURES

Oil maintenance men especially appreciate Simazine 50W's Seven Safety Features. This new herbicide is safe to humans and animals, non-flammable, non-corrosive, non-abrasive, and presents no conductivity problem or drift hazard. Check the panel for these and all of Simazine 50W's Seven Safety Features – and compare.

TECHNICAL SERVICE

Geigy Technical Service is readily available to serve you. Write for additional information, the name of your nearest Simazine 50W distributor, or ask to see a Geigy technical representative. Address: Geigy Agricultural Chemicals, P.O. Box, 430, Yonkers, N. Y.

* "SIMAZINE" is a trademark of Geigy Chemical Corporation

GEIGY AGRICULTURAL CHEMICALS • *Division of Geigy Chemical Corporation* • Saw Mill River Road, Ardsley, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

ACETYLENE FROM NATURAL GAS OR NAPHTHA

By Societe Belge de l'Azote-Kellogg

Success of the SBA-Kellogg acetylene processes—industry's most advanced approach to the continuous production of high purity C_2H_2—stems mainly from burners developed by Societe Belge de l'Azote.

Burner Type I for natural gas feed, for example, avoids pre-ignition or flashback when gas and oxygen are introduced at economic, elevated preheat temperatures; minimizes heat losses by maintaining flame stability at temperatures as high as 1400-1600K; optimizes yield and prevents overcracking through reaction chamber design; and continuously removes carbon in operation.

Full details on the SBA-Kellogg high purity acetylene processes—designed to use natural gas, naphtha or other liquid feedstocks, and on the process equipment, are contained in a new 6-page Kellogg folder and an 8-page reprint of a detailed article just published in a technical publication. Write Kellogg for your copies.

These folders tell the complete story of the SBA-Kellogg Acetylene Processes

THE M. W. KELLOGG COMPANY

711 Third Avenue, New York 17, N.Y. *A Subsidiary of Pullman Incorporated*

The Canadian Kellogg Company Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York
Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

40 MPH!

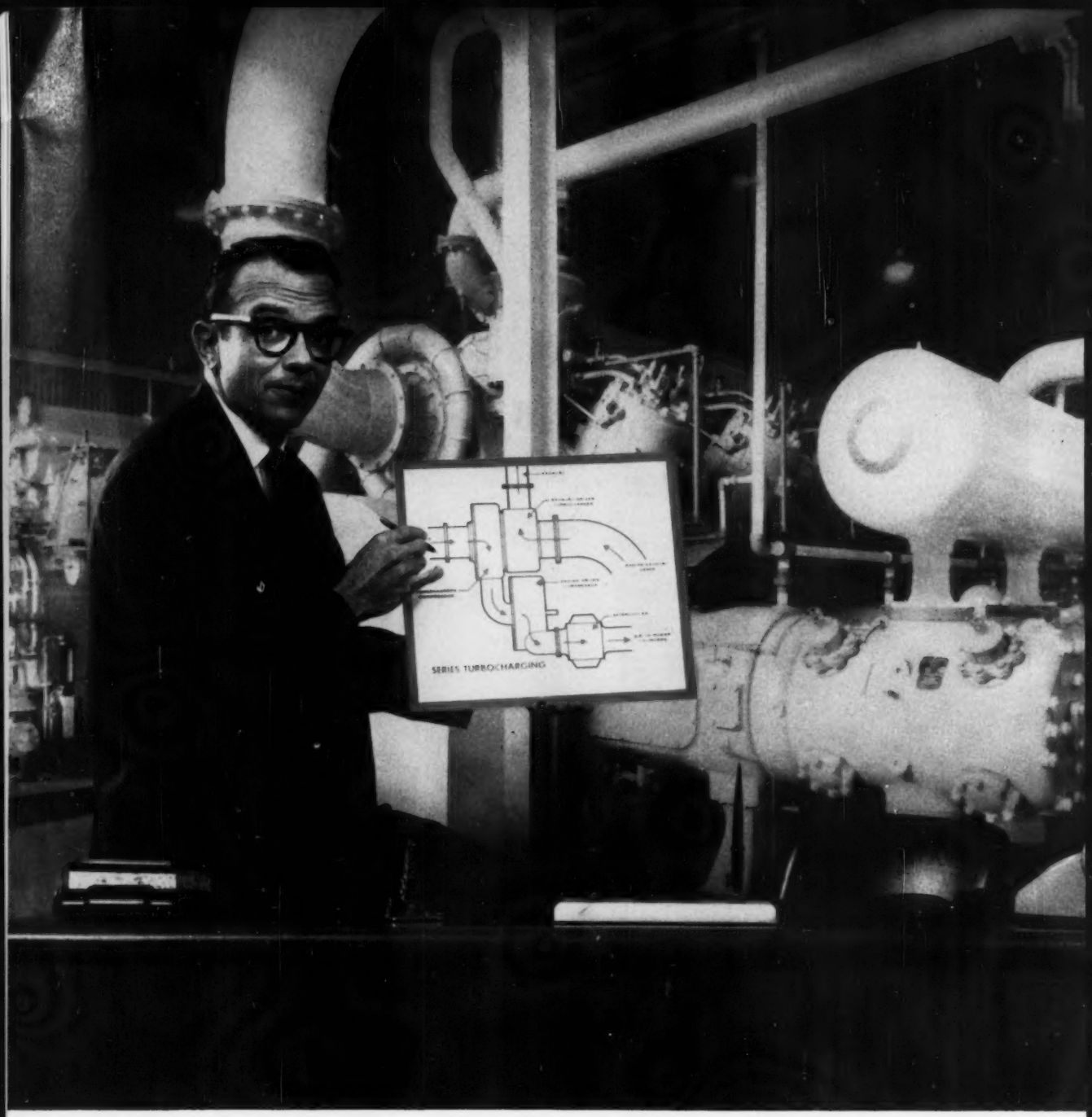
Fastest crew boat ever built! Powered by two Solar Jupiter® gas turbine engines

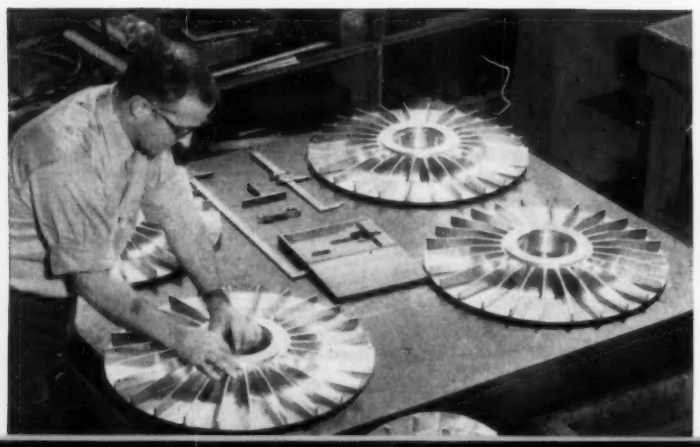
THIS SPEEDY 52-FOOT aluminum-hulled craft can save up to several thousand dollars daily in commercial operations. Built by Higgins, Inc., the boat is powered by two Solar Jupiter 500 hp gas turbines. Weight of the complete power package is 4400 lb—1/6th the weight of conventional engines of equivalent power and service life. Other Jupiter advantages include instant power for extreme maneuverability, no vibration, easy maintenance, low noise and ability to burn a variety of fuels. Write for details to Dept. F-119, Solar Aircraft Company, San Diego 12, California.

ENGINEERS WANTED! *Challenging projects, unlimited opportunities with Solar. Write today!*

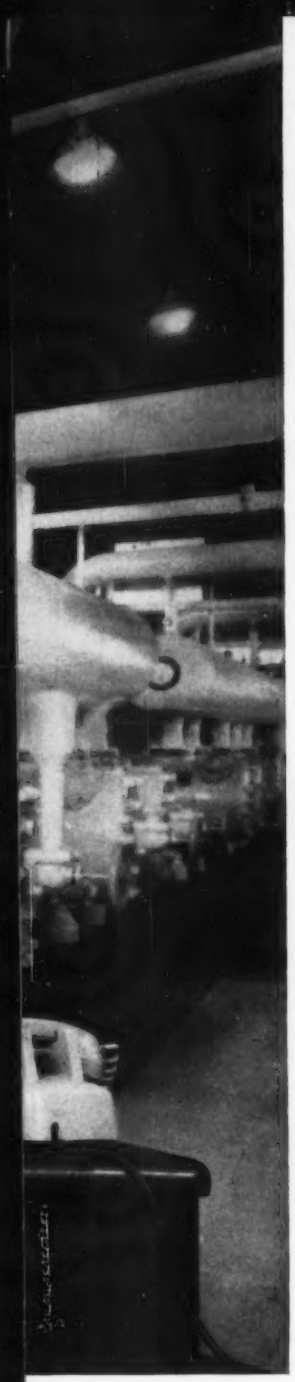
SOLAR AIRCRAFT COMPANY — SAN DIEGO, DES MOINES

For more data on advertised products, use Readers' Service Cards, last page.





Built Entirely By Cooper-Bessemer. Cooper-Bessemer is able to ideally integrate turbocharger system and compressor engine performance . . . and to assure highest standards of materials and workmanship for these precision components.



Donald L. Reed, *Manager Gas Engine Compressor Sales, The Cooper-Bessemer Corporation, explains . . .*

How you get 40% more power with the latest Cooper-Bessemer V-Angle Compressors

The diagram explains Cooper-Bessemer's series turbocharging development. A step beyond ordinary turbocharging, *series turbocharging* assures an extra performance margin throughout the operating range, plus these unmatched advantages:

40% greater horsepower than predecessors of the same bore, stroke and speed.

Reduced fuel consumption . . . as low as 6900 Btu/bhp/hr—proof of series turbocharging's greater efficiency.

Space savings. Greater output, combined with inherent compactness of V-angle design, results in lowest cost per horsepower for housing, foundation, piping, maintenance, supervision.

Superior altitude performance. Inherent flexibility of the series turbocharging system allows unique altitude compensation to assure full rated horsepower and highest efficiency.

Full range response. The Cooper-Bessemer series turbocharging principle *automatically* provides optimum supercharging regardless of the degree of load.

WRITE FOR BULLETINS . . . complete details on Cooper-Bessemer Series Turbocharged V-Angle Compressors in GMVC Bulletin 85 and GMWC Bulletin 86. Free on request.

Latest Bulletins. GMVC Bulletin 85, 1100 to 1800 bhp; GMWC Bulletin 86, 2000 to 3500 bhp.

BRANCH OFFICES: Grove City • New York • Chicago • Washington • San Francisco Los Angeles • Houston • Dallas • Odessa • Pampa • Greggton • Seattle • Tulsa • St. Louis • Kansas City • Minneapolis • New Orleans • Shreveport • Casper

SUBSIDIARIES: Cooper-Bessemer of Canada, Ltd. . . . Edmonton • Calgary Toronto • Halifax

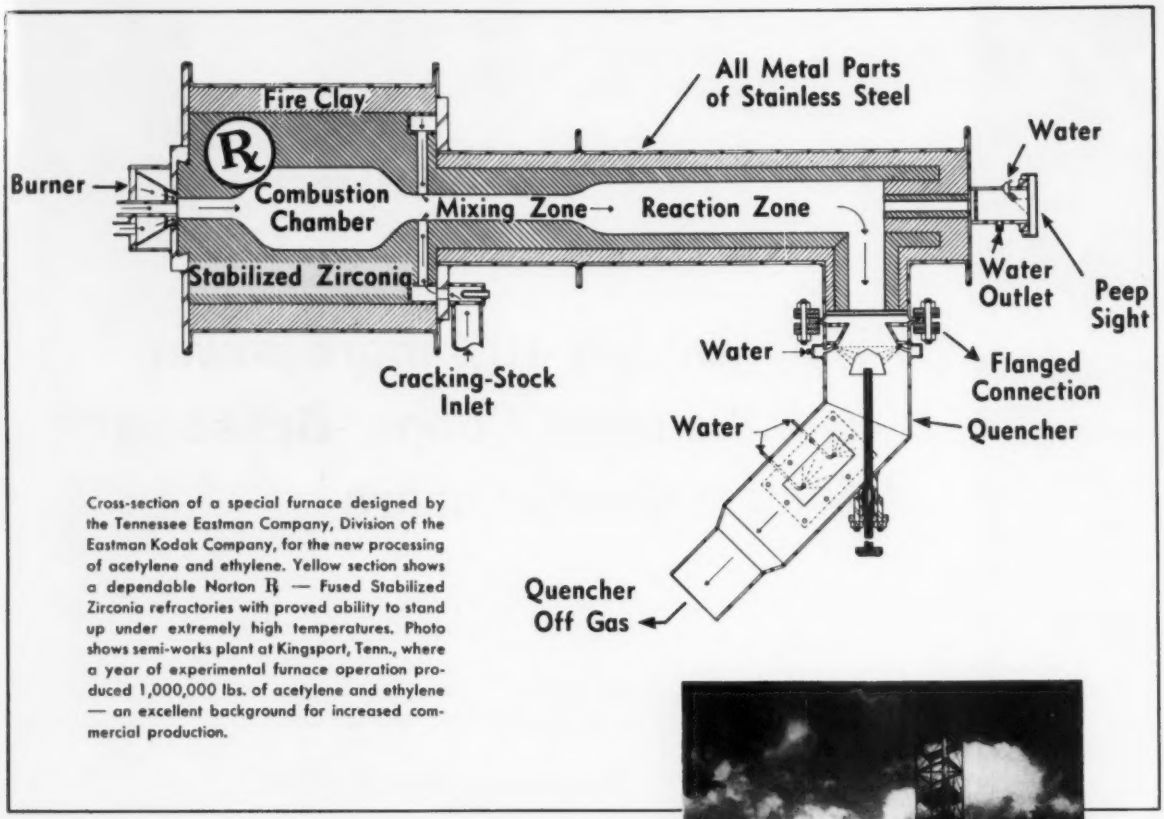
Cooper-Bessemer International Corporation . . . New York • Caracas • Mexico City

C-B Southern, Inc. . . . Houston

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL, ENGINE OR MOTOR DRIVEN



Cross-section of a special furnace designed by the Tennessee Eastman Company, Division of the Eastman Kodak Company, for the new processing of acetylene and ethylene. Yellow section shows a dependable Norton Rx — Fused Stabilized Zirconia refractories with proved ability to stand up under extremely high temperatures. Photo shows semi-works plant at Kingsport, Tenn., where a year of experimental furnace operation produced 1,000,000 lbs. of acetylene and ethylene — an excellent background for increased commercial production.

New Tennessee Eastman Process uses NORTON Zirconia Refractories

Zirconia lining permits high, uniform heat flux for improved production of acetylene and ethylene.

Heart of Tennessee Eastman Company's advancement in processing acetylene and ethylene is a newly designed furnace. Here, saturated hydrocarbons are decomposed in hot combustion gases. High temperature heat must be supplied rapidly and uniformly. Since an endothermic reaction is involved, a zirconia lining was specified because of its ability to insulate at high temperatures and to conserve valuable heat. This furnace operation required refractories capable of withstanding continuous operation at temperatures in excess of 2,000°C.

Norton Fused Stabilized Zirconia was specified in special shapes for the inner courses of the combustion chamber, mixing zone and reaction zone. As a result, the structural stability and suitability of the furnace for continuous use was confirmed when the combustion chamber was found to be in excellent condition after 100 days of operation.

The development of Fused Stabilized Zirconia is a typical Norton aid in utilizing higher temperatures for greater efficiency and output. Norton was first to bring this valuable material out of the experimental stage. Now it is used in many forms for commercial production.

Investigate Norton Rx's — refractories *engineered and prescribed* to save time, work and money. See your Norton Representative or write to NORTON COMPANY, Refractories Division, 461 New Bond St., Worcester 6, Massachusetts.

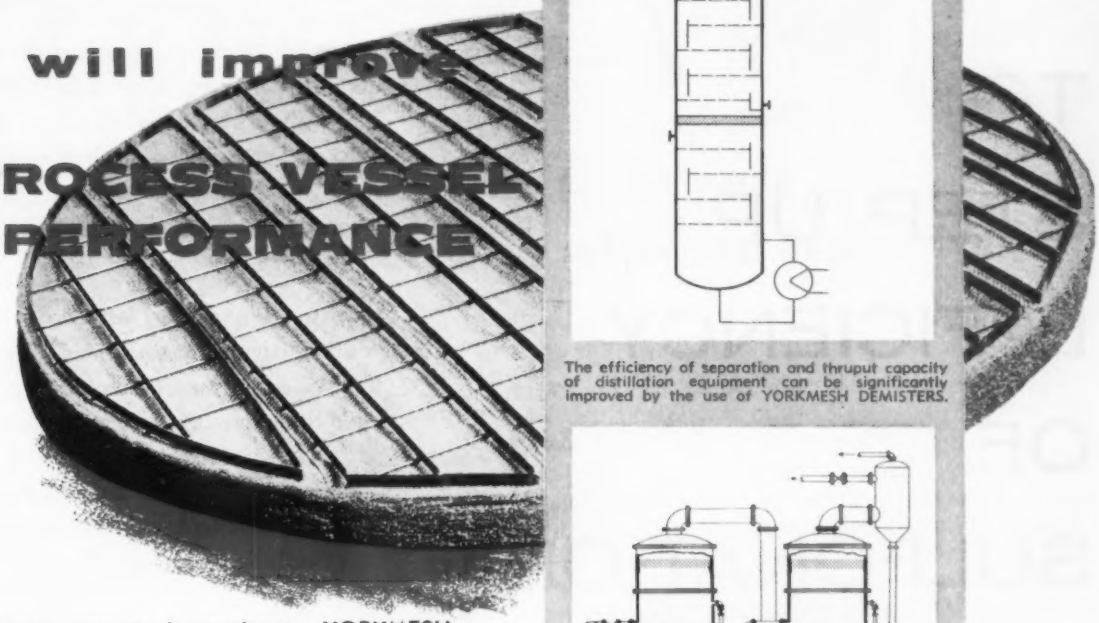
NORTON
REFRACTORIES
Engineered... Rx ...Prescribed

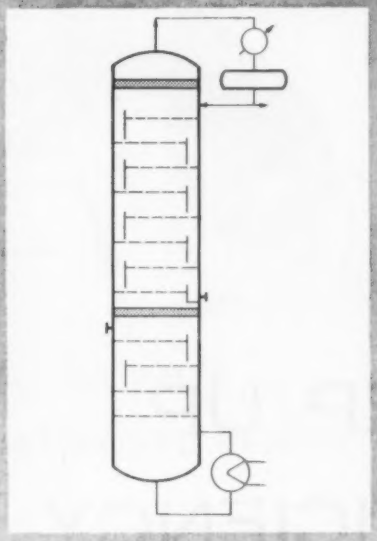
Making better products . . . to make your products better

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — BEHR-MANNING DIVISION Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

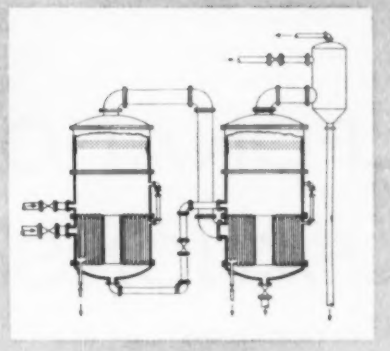
YORKMESH® DEMISTERS

will improve PROCESS VESSEL PERFORMANCE

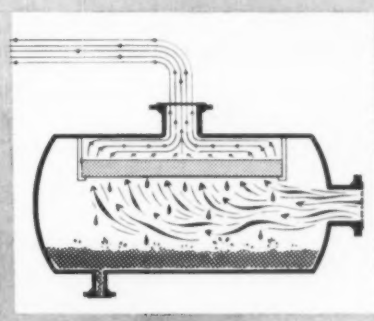




The efficiency of separation and thruput capacity of distillation equipment can be significantly improved by the use of YORKMESH DEMISTERS.



YORKMESH DEMISTERS installed in evaporators avoid product loss and provide clean condensate.



YORKMESH DEMISTERS installed in Knock-Out Drums result in high separation efficiency at low pressure drop.

It will pay you to investigate YORKMESH DEMISTERS if your process vessels need a lift in efficiency. The versatile knitted wire-mesh pads are being used more and more throughout industry to ***stop*** liquid entrainment and improve the performance of:

Vacuum Towers, Distillation Equipment, Gas Absorbers, Scrubbers, Evaporators, Knock-Out Drums, Steam Drums and many others.

Here is what happens when YORKMESH DEMISTERS are installed:

1. As vapor disengages from liquid it carries with it fine liquid droplets.
2. When the vapor stream passes thru the fine wire mesh, the liquid droplets impinge on the wire surfaces, coalesce in to large drops, and fall.
3. The vapor is now dry and free from entrained liquid.

Send us details on your type of process vessel or operation, vapor flow rate, pressure, temperature, and density or molecular weight; approximate amount of entrained liquid, viscosity, and specific gravity . . . for existing equipment advise dimensions, indicate vertical or horizontal vessel and material of construction required for mesh and grids. Complete details will make it possible for us to present our recommendations and quotation.

YORK

OTTO H. YORK CO., INC.

6 CENTRAL AVE. • WEST ORANGE, N. J.

For more data on advertised products, use Readers' Service Cards, last page.

TO STEP UP EFFICIENCY OF SULFONATIONS, SULFATIONS

...USE SULFAN®

(stabilized sulfuric anhydride)

Step up sulfonation efficiency. "Sulfan" has 99.5% SO_3 available for sulfonation reactions. For many applications, "Sulfan" offers nine times as much usable SO_3 as 100% sulfuric acid . . . over three times as much as 20% oleum. This can mean a considerable saving in operating costs.

Step up processing efficiency. With "Sulfan," there is no waste acid. This means that you can increase batch sizes or get more rapid through-put . . . often double without increasing size of equipment! Since no water is formed when "Sulfan" is used for sulfonation, the waste acid problem inherent with use of sulfuric acid or oleum is eliminated.

These benefits alone make "Sulfan" worth your thorough investigation. You may be able to realize other important process economies and advantages too.

"Sulfan" is readily available in tank cars and 750-lb. drums.

Write today for confidential technical information on the use of "Sulfan" in *your* process.

Use "Sulfan" for:

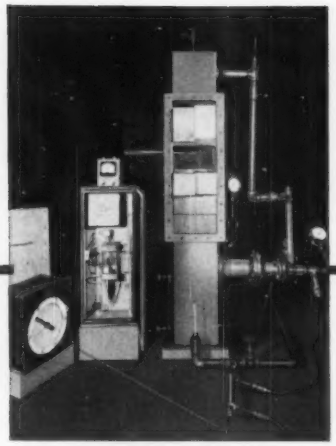
Synthetic Detergents
Dye Intermediates
Petroleum Fractions
Textile Specialties
Pharmaceuticals
Fatty Acids
Lubricant Additives
Agricultural and Industrial Emulsifiers

Basic Chemicals for American Industry

Allied Chemical

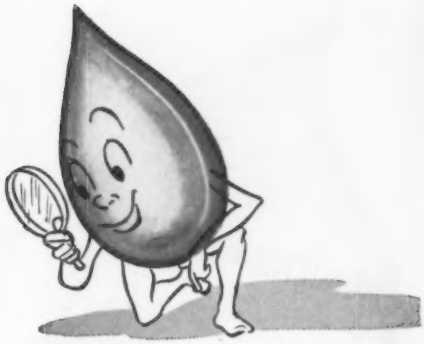
GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.



Pilot tray-type deaerator shown with continuous oxygen analyzer in test setup.

ALLIS-CHALMERS DEAERATORS



Looking for more effective deaeration?

Outdoor installation of Allis-Chalmers deaerator in southern chemical plant.

● If so — you'll be interested in the continuing research program at Allis-Chalmers to evaluate all factors in the design of deaerators.

This program includes the use of a specially built pilot deaerator with automatic oxygen analyzer and recorder. Operating factors and deaerating compartment design can be varied to study length of spilling edge of trays, heating area and method of flow. Results obtained with this setup are quickly translated into deaerators designed for optimum performance.

In addition to this continuous testing, metallurgical research is being done to select the most suitable materials.

Over 30 years' experience in the field of power plant water conditioning, and over 75 years' experience in the field of steam power plant equipment including deaerating-type condensers, provide further valuable background. No other manufacturer so completely insures deaerator performance.

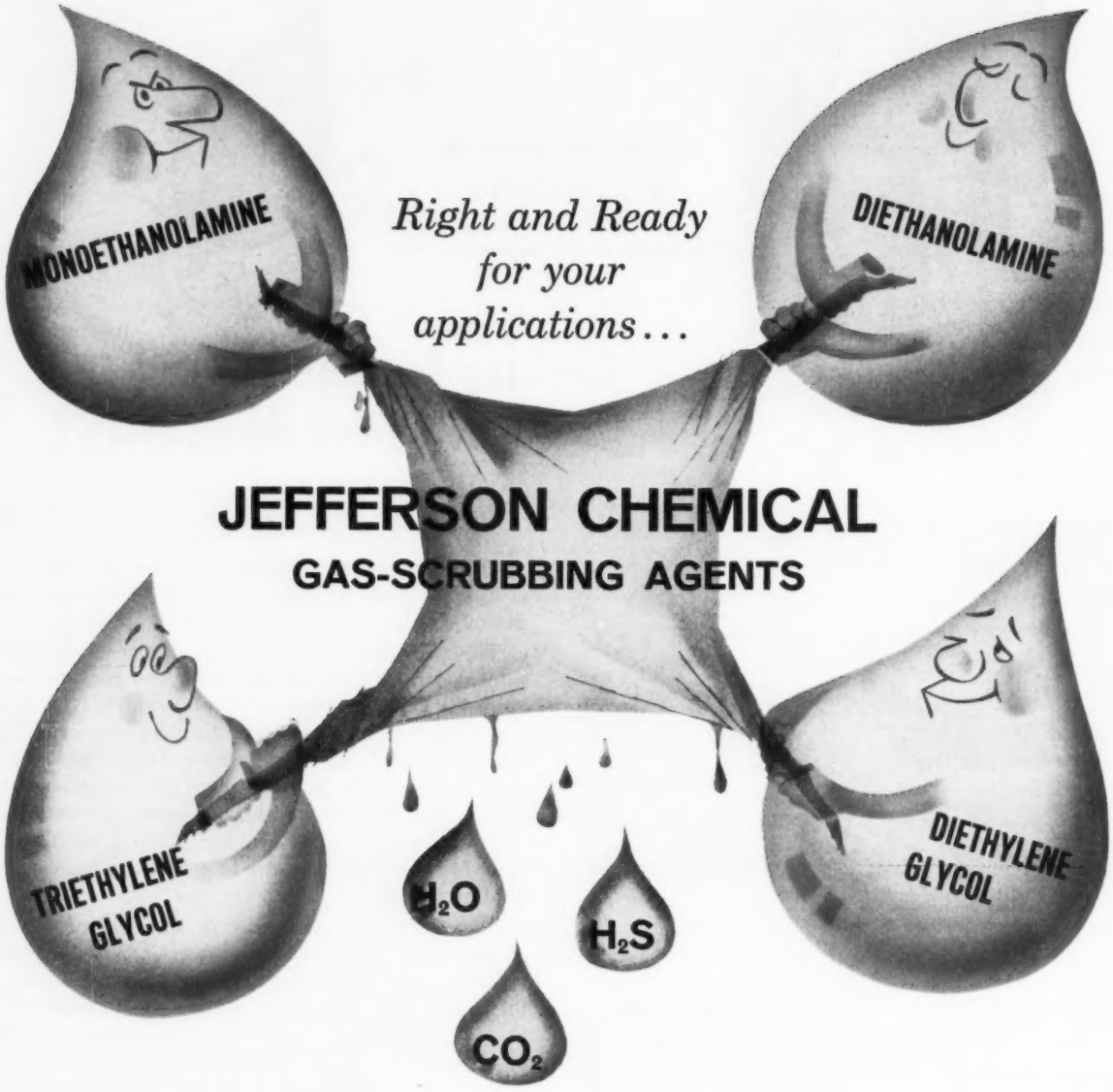
For further information contact your nearby A-C office or write for Bulletin 28B8853, Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wis.

Cross section of tray-type deaerator shows water and steam flow.

ALLIS-CHALMERS

A-5674

For more data on advertised products, use Readers' Service Cards, last page.



Whatever your applications in natural gas sweetening, refinery stream sweetening, sulfur recovery, gas dehydration, and carbon dioxide absorption . . . Jefferson Chemical has the right products in the special grades and quantity you desire.

You may utilize the most convenient size shipment and carrier for your production and storage needs . . . single-product or compartmented tank cars of 4,000- to 10,000-gallon capacity, single-product or compartmented tank wagons of 1,000 to 4,000 gallons, or 55-gallon drums.

Combine these high purity chemicals and prompt, accurate shipments with Jefferson's experience and complete willingness to render every possible technical assistance, and you have a first-rate source for your "Gas-Scrubbing" needs. Ask your Jefferson man at 1121 Walker Avenue, Houston 2, Texas.

JEFFERSON CHEMICAL COMPANY, INC.

HOUSTON • NEW YORK • CHICAGO • CLEVELAND
CHARLOTTE • LOS ANGELES

Ethylene Oxide, Glycols, Dichloride • Ethanolamines • Morpholine • Piperazine
Polyethylene Glycols • Nonyl Phenol • SURFONIC® Surface-Active Agents
Ethylene Carbonate and Propylene Carbonate • Caustic Potash • Caustic Soda
Soda Ash • Sodium Bicarbonate

Essential Chemicals From Hydrocarbon Sources

110

For more data on advertised products, use Readers' Service Cards, last page.

insert the plug ...save the valve!

Safely recover expensive valves when abandoning temporary or semi-permanent connections by using Mueller® Save-A-Valve Drilling Nipples.

A NO-BLO® Completion Plug is inserted through the valve under pressure and screwed into the top of the nipple. This exclusive plug, with "O" ring seal, effectively seals the connection while the valve is removed and the nipple is capped.

Built-in pressure equalizing valve in the plug permits it to be removed at anytime. Connection can be used again and again.

These features of Mueller Save-A-Valve Drilling Nipples permit the active use of every valve in a system—greatly reducing the total number of valves needed. They are typical, however, of the great attention to detail in research, design and engineering that become a part of every Mueller product.

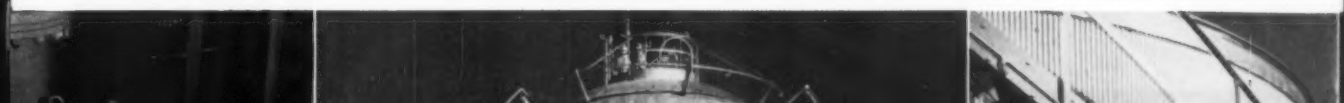
NO-BLO

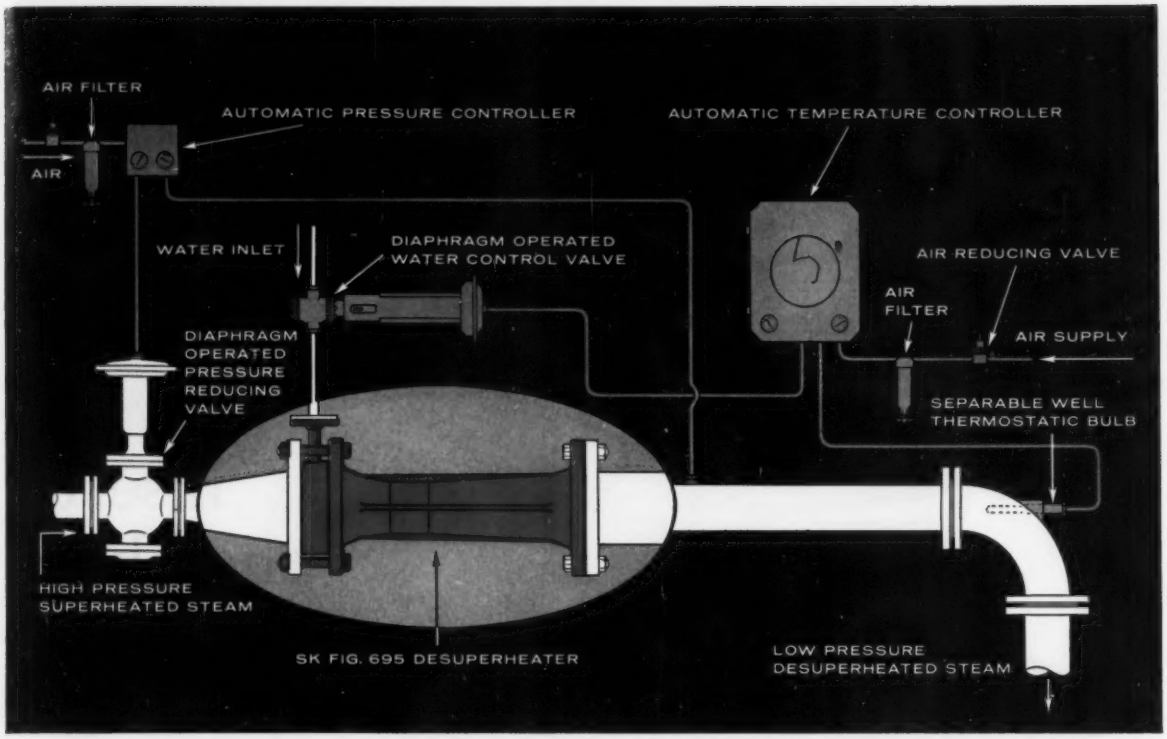
MUELLER CO. **DECATUR, ILL.**

Since 1857 — Serving the Water and Gas Industries — Quality

Factories at: Decatur, Chattanooga, Los Angeles; In Canada: Mueller, Limited, Sarnia, Ontario

For more data on advertised products, use Readers' Service Cards, last page.

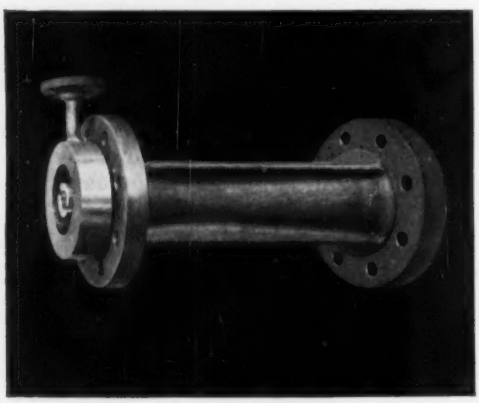




Reduce Steam Temperature for Process Operations

with this light, easily-controlled Desuperheater

SK Fig. 695 Venturi Type Desuperheater. An important feature of this desuperheater is the fact that the water need not be at higher pressure than the steam entering the desuperheater. As noted in description, right, water can enter the unit at inlet steam pressure.



The SK Venturi Type Desuperheater, shown in the illustrations above and at left, is designed to reduce the temperature of superheated steam to the lower temperatures required for use in process operations and for operating plant auxiliaries.

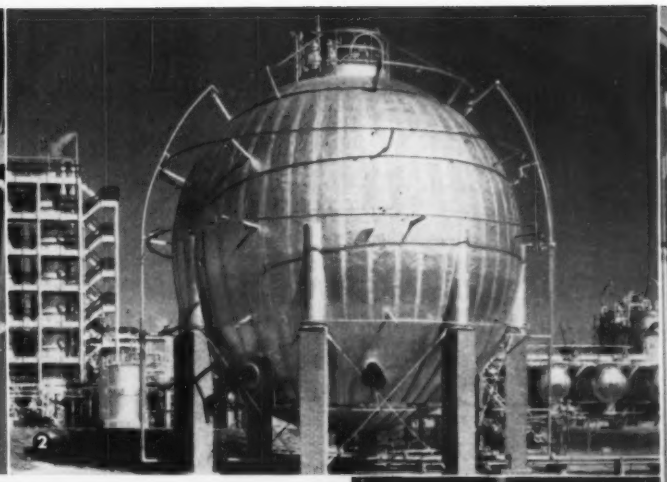
These Desuperheaters are light in weight and small in dimensions—are supported directly by the superheated steam line. In addition, they are simple in construction, provide straight-through flow with only a small pressure drop. Because these units are designed for application with automatic control, they are particularly well suited for process and petroleum plants where steam flow varies. They can, however, be used without controls where steam flow is steady. In such cases only a separator need be added.

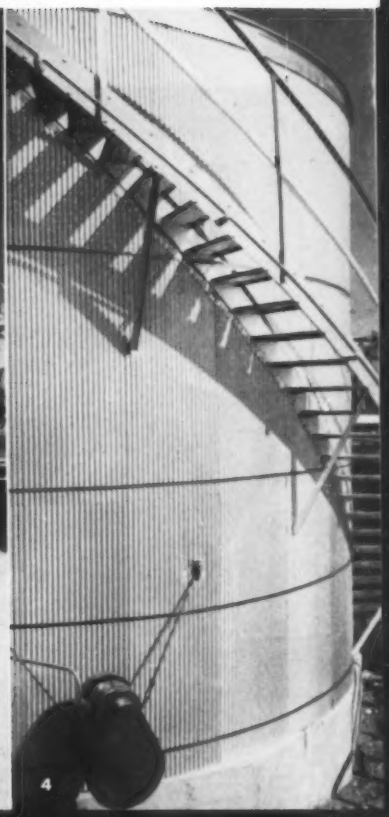
The Venturi Type Desuperheater reduces steam temperature by bringing water into contact with the superheated steam. The water pressure is low since it need only equal the operating steam pressure. The water is preheated in the chamber around the water diffuser and issues, through many small jets, into the steam stream. Since the steam-water mixture is discharged through the desuperheater outlet in a fog-like condition, without contacting the sidewalls, maximum desuperheating effectiveness is obtained and minimum wear occurs in the discharge piping.

The particular desuperheater shown is one of four types made by SK for process plants. Complete details on all types are contained in Bulletin 6D. Write for a copy.

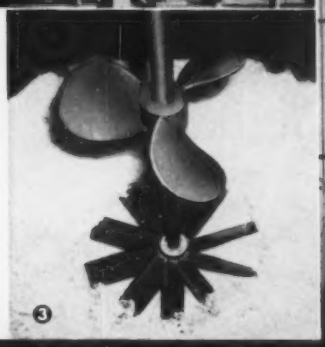
JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin 17-A.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS SINCE 1876
2257 State Road, Cornwells Heights, Bucks County, Pa.

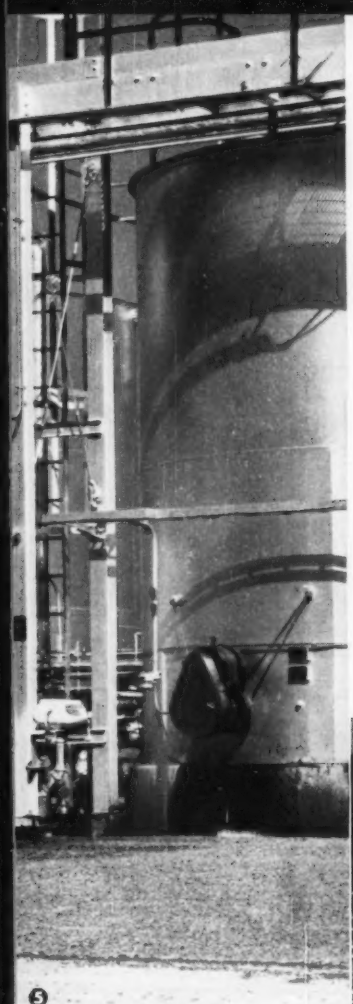




1. Ore purification in pressure vessel with Nettco tank top turbine mixer.
2. Butadiene blending with Nettco side drive mixers having replaceable, mechanical seals.
3. Violent agitation as produced by Nettco's unique combination of turbine and propeller drives.
4. Maintaining product uniformity in Styrene storage tanks with Nettco side drive mixers.
5. Blending with Nettco side drive mixer in storage tank containing 20% caustic solution.
6. Small batch blending with versatile Nettco portable mixer.
7. Standardization of finished product with rugged Nettco vertical turbine mixers.



Improved Processing through Engineered Agitation



WHAT'S THE BEST MIXER FOR YOUR PARTICULAR JOB?

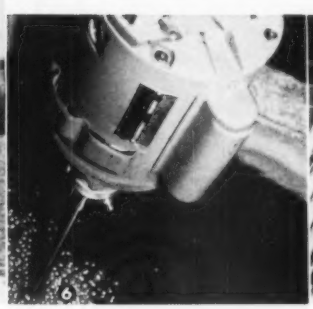
FLUID MIXING demands specialized, highly technical know-how. There is no single mixer which is "best" for every job. Only a mixing specialist can combine and coordinate agitation technology with mixer design and optimum horsepower to achieve an exacting result.

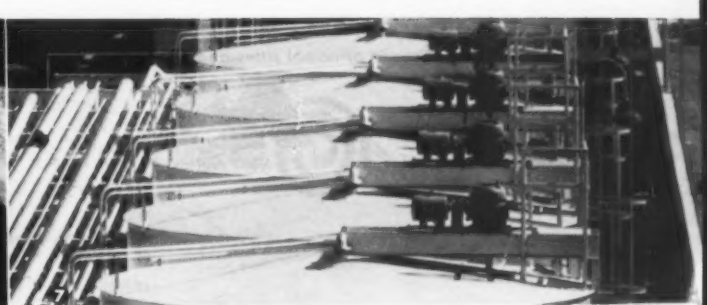
NETTCO ENGINEERED AGITATION provides a full evaluation of all application specifications, an analysis of performance data from pilot runs, and the careful selection of high quality, standard Nettco components to suit the specific job. *You* are assured of the result you want.

BACKED BY A FULL LINE . . . side drive, tank top, portable or tripod and continuous pipeline mixers . . . and thousands of performance-proven installations, like those illustrated, NETTCO can provide invaluable help in determining your fluid mixing needs. See *Chemical Engineering Catalog* or *Refinery Catalog* for our nearest representative, or write for Bulletin 582, New England Tank and Tower Co., 81 Tileston Street, Everett 49, Massachusetts.

NETTCO

ENGINEERED AGITATION SPECIALISTS



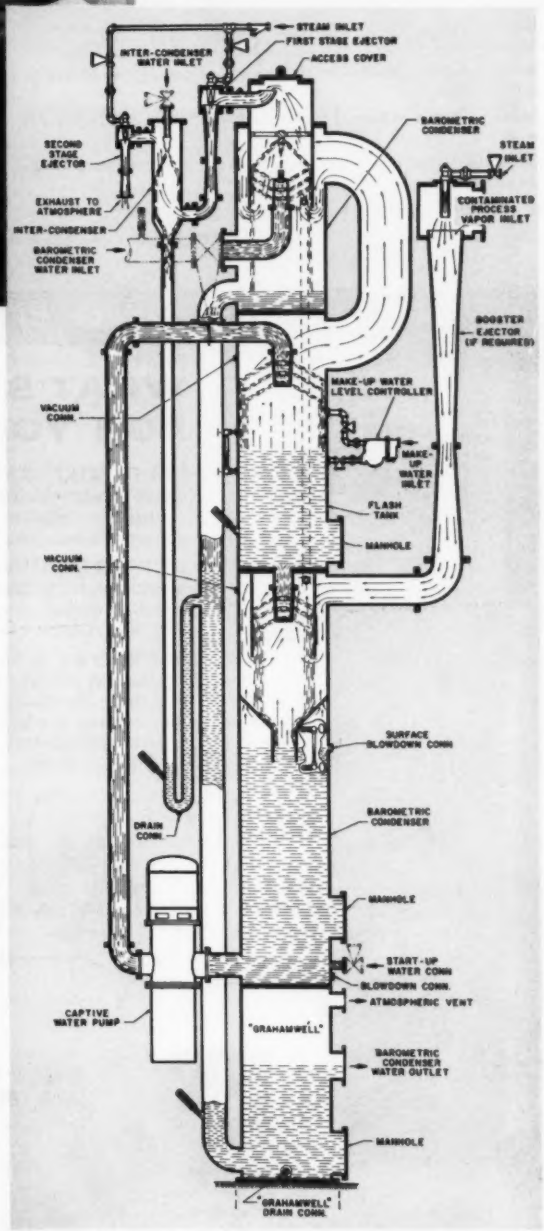


Don't wait 'til next spring!

If you are contaminating your plant water supply, it will be worse during the hot months of 1959

Here is your solution — the Graham

CAPTIVE WATER COOLANT UNIT



The Graham Captive Water Unit condenses your contaminated process vapors without carrying foreign material into your plant water supply. The Graham Captive Water Unit condenses all your noxious vapors with its own independent water supply. This water supply in itself is cooled in the flash cooler section of the unit and thereby allows these foreign materials to be removed from the system without troubles.

We call your attention to the unit shown here and suggest that you investigate this unit for your

Deodorizers
Petroleum Refinery Vacuum Units
Vacuum Acid Concentrators
Paper Mill Vacuum Evaporators
Fish Stick Liquor Evaporators
Evaporated Milk Vacuum Pans
Urea Process Evaporators
Food Process Evaporators
—and many others.

For trouble free operation without continuous maintenance consult us on your contaminated vapor problems and the Graham Captive Coolant Condenser.

GRAHAM MANUFACTURING CO., INC.
Heliflow Corporation
415 LEXINGTON AVE., NEW YORK 17, N. Y.
Offices in principal cities and Canada

SINCE 1936

Now! From Annin ...the Finest in Electro-Pneumatic Actuators

Annin's Model 30,000 transducer, coupled with the Annin Domotor, gives you greater range of adjustment, unequalled stability, and exceptional dynamic characteristics

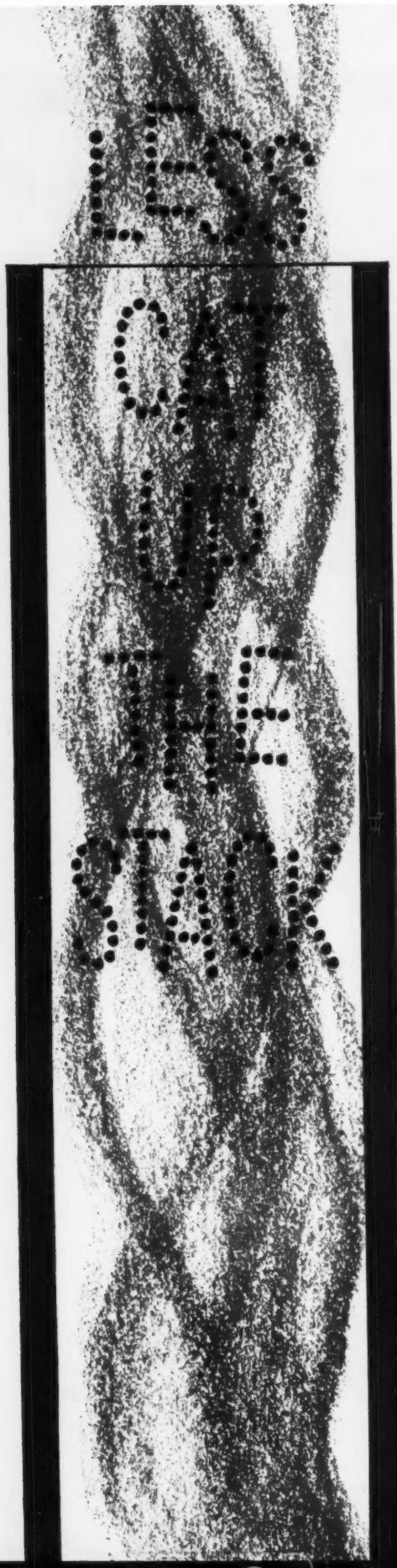
The Model 30,000 has been developed to provide process engineers with a practical transducing element for converting a small electrical signal to an accurate and stable pneumatic output pressure. It embodies only four basic sub-assemblies, which minimize motion and wear, simplify adjustment and installation. The Model 30,000 features full-scale zero adjustment and a wide range of span settings for split range and sequencing applications. Absence of complex components, together with minimum installation,contribute to low maintenance. Linearity and accuracy reach a new high in electro-pneumatic transducing with the Model 30,000. *Technical data on request*

Send for your copy
of Annin's new Catalog 1500-D

Annin VALVES

THE ANNIN COMPANY Division of The Annin Corporation
1040 S. Vail Ave., Montebello, California

For more data on advertised products, use Readers' Service Cards, last page.



with Davison Catalysts

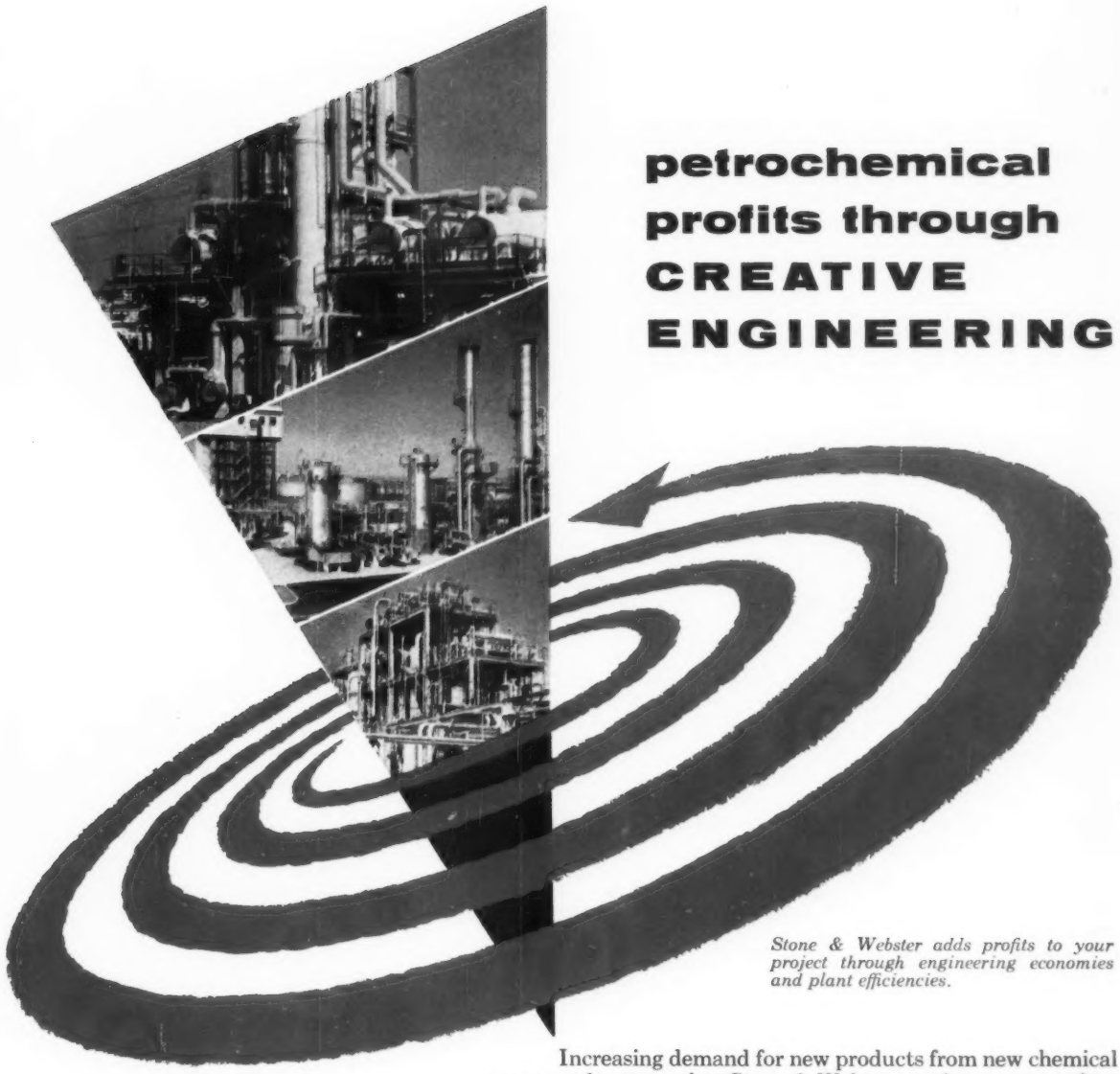
Your stack carries away regeneration gases —not catalyst—when you put Davison in your unit. Here's why:

With Davison Catalysts you get the lowest amount of unretainable fines.

With Davison Catalysts you get lower attrition. The lower breakdown rate of Davison Catalysts means you get the fines you need without light particles escaping up the stack.

The reason: *balanced density*. There's a Davison Catalyst to suit your application. Write Department 3912, today for Product Service Bulletin No. 59-101.

W.R. GRACE & CO.
DAVISON CHEMICAL DIVISION
BALTIMORE 3, MARYLAND



petrochemical profits through CREATIVE ENGINEERING

Stone & Webster adds profits to your project through engineering economies and plant efficiencies.

Increasing demand for new products from new chemical compounds means that Stone & Webster engineers must often develop new designs and new construction techniques for new process plants throughout the world.

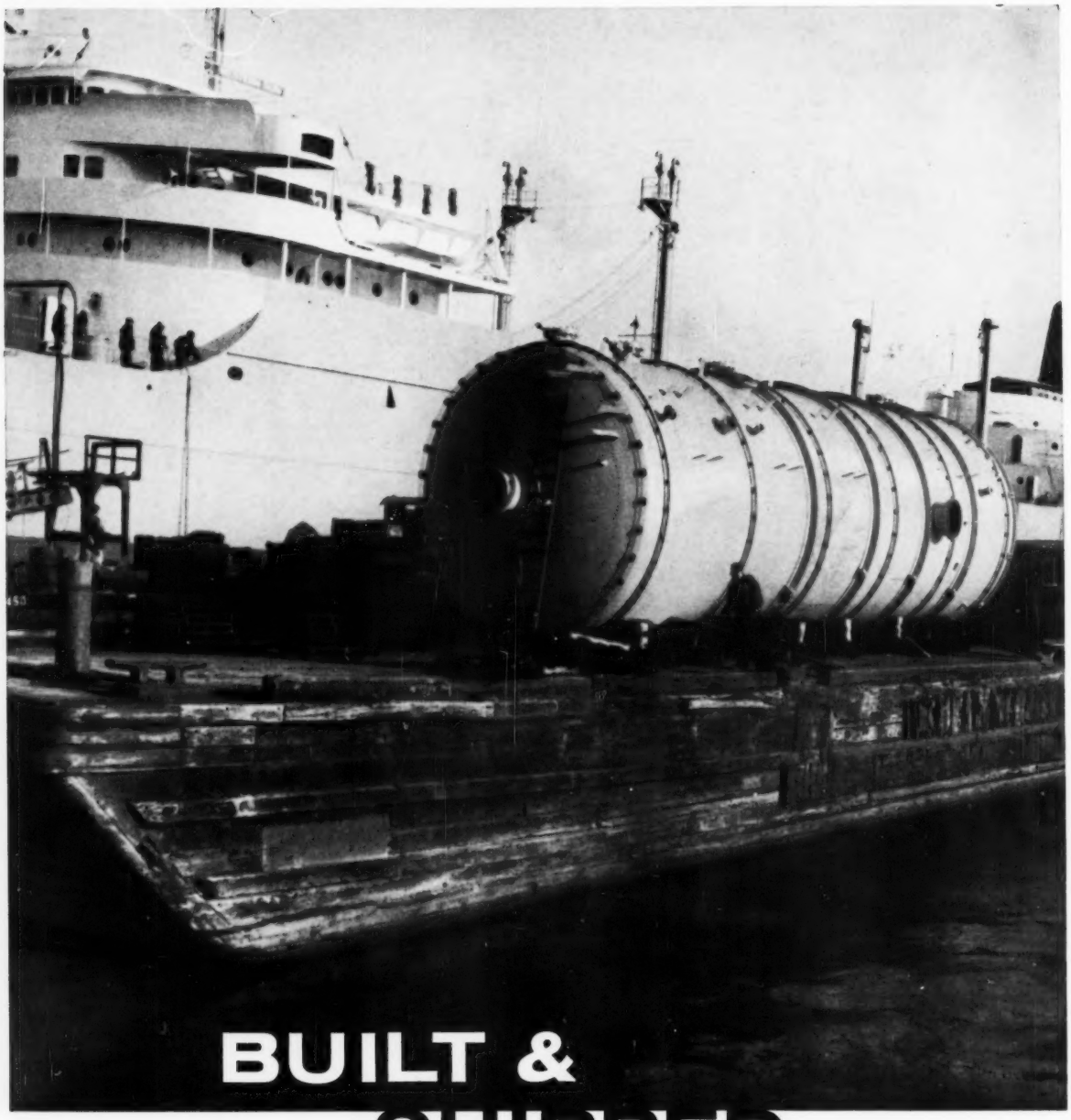
And it is precisely this skill and experience in creative engineering that distinguishes a Stone & Webster project . . . whether it's a chemical plant, refinery, power station or pulp and paper mill. For nearly 70 years Stone & Webster has been associated with *profitable* engineering projects of every size in nearly every industry.

Stone & Webster assumes complete responsibility for the creation of an entire installation . . . or is available for consultation on special engineering problems. Call or write our nearest office for further information.

STONE & WEBSTER
ENGINEERING CORPORATION

Affiliated with STONE & WEBSTER ENGINEERING LIMITED (LONDON)

New York • Boston • Chicago • Pittsburgh • Houston
San Francisco • Los Angeles • Seattle • Toronto

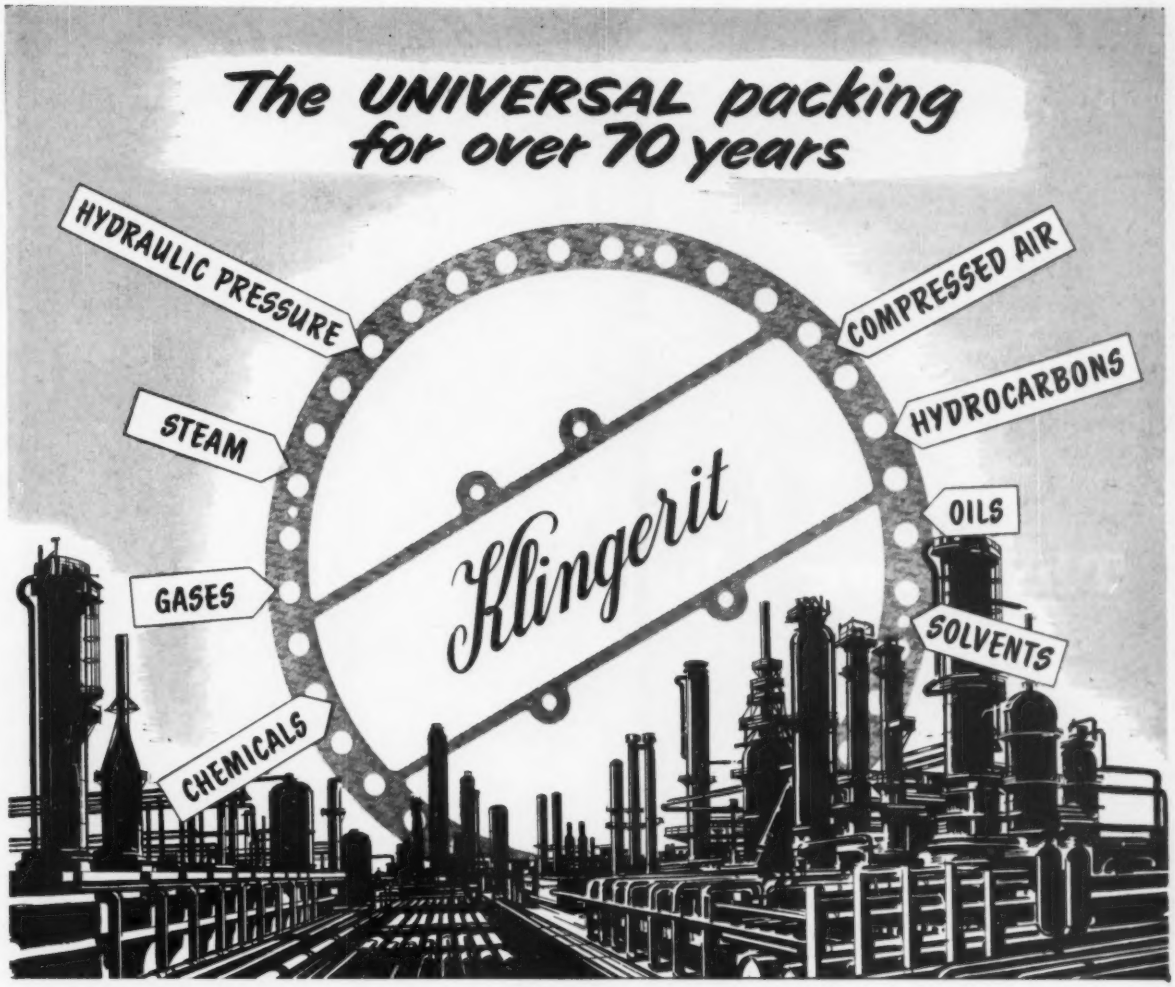


BUILT & SHIPPED... ON TIME

Today, modern oil refineries and chemical plants require more and more complicated pieces of fabricated equipment—too large to ship by rail or road. To meet this need, Sun Ship specializes in building and shipping large carbon or alloy steel units by water (inland, coastal or overseas)... directly from our plant.

SUN SHIP
BUILDING & DRY DOCK CO.
CHESTER, PENNSYLVANIA

For more data on advertised products, use Readers' Service Cards, last page.



Know-how counts with packings—there is no substitute for experience. Klingerit compressed asbestos sheet packing has 70 years experience of manufacture behind every piece—no wonder it is relied on when engineers want joints to last!

Klingerit and its companion special purpose Klinger sheet packings provide sure answers to your packing problems. In sheets, ready cut joint rings or the largest precision made heat exchanger gaskets, the name Klinger guarantees top quality.

KLINGERIT: Universally used for steam, chemicals, gases and hydrocarbons at temperatures up to 500°C and pressures up to 6,000 p.s.i.

KLINGERIT 1000: Wire reinforced for extreme temperatures and pulsating pressures.

KLINGER-ACIDIT: Specially made to resist hot nitric, sulphuric, hydrochloric and organic acids.

KLINGER-OILIT: Bonded with synthetic rubber for maximum resistance to oils, hydrocarbons, refrigerants and solvents.

R.K.: An excellent packing for general engineering practise and other less severe conditions.

Our technical staff will be glad to give you further information. Write today for the Complete Klinger Packing Catalog.

RICHARD KLINGER INC. 550, FOURTH AVENUE, BROOKLYN 15, NEW YORK
SOUTH 8-6747

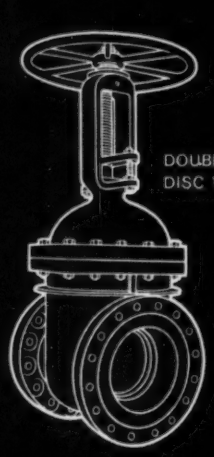
Manufacturing Licensees for Canada

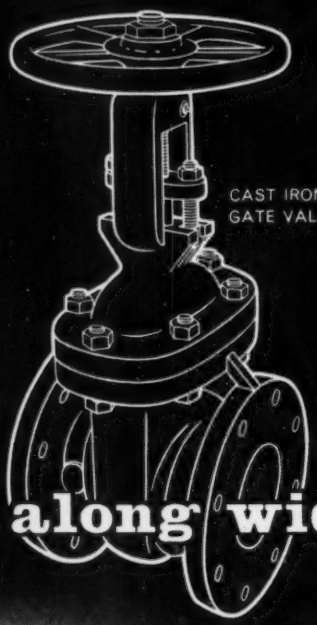
JOSEPH ROBB & COMPANY LIMITED, 5575, COTE ST. PAUL ROAD, MONTREAL, 20, CANADA
Telephone: GLENVIEW 9151
Branches at: SYDNEY, HALIFAX, OTTAWA, TORONTO, HAMILTON, WINNIPEG, EDMONTON, VANCOUVER, QUEBEC CITY

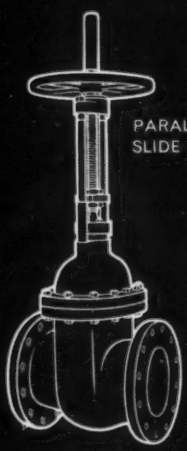
RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND.

GA44/58/1

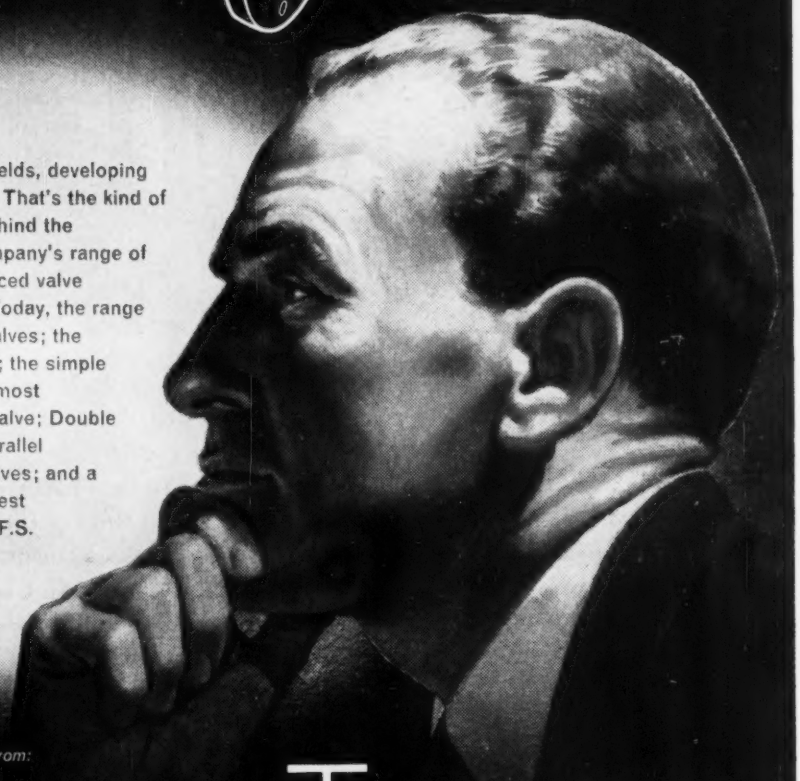
For more data on advertised products, use Readers' Service Cards, last page.


DOUBLE
DISC VALVE


CAST IRON
GATE VALVE


PARALLEL
SLIDE VALVE

Thinking along wider lines . . .



. . . entering new fields, developing new ideas. That's the kind of look-ahead thinking behind the Triangle Valve Company's range of some of the most advanced valve designs available. Today, the range includes Alloy Steel Valves; the Cast Iron Gate Valve; the simple action Line Blind Valve; a most efficient Wellhead Valve; Double Disc S.S. Pipeline and Parallel Slide C.S. Steam Valves; and a whole series of the latest design pipe fittings in D.F.S. and malleable iron.

Full technical details and specifications from:

TRIANGLE VALVE CO. LTD.

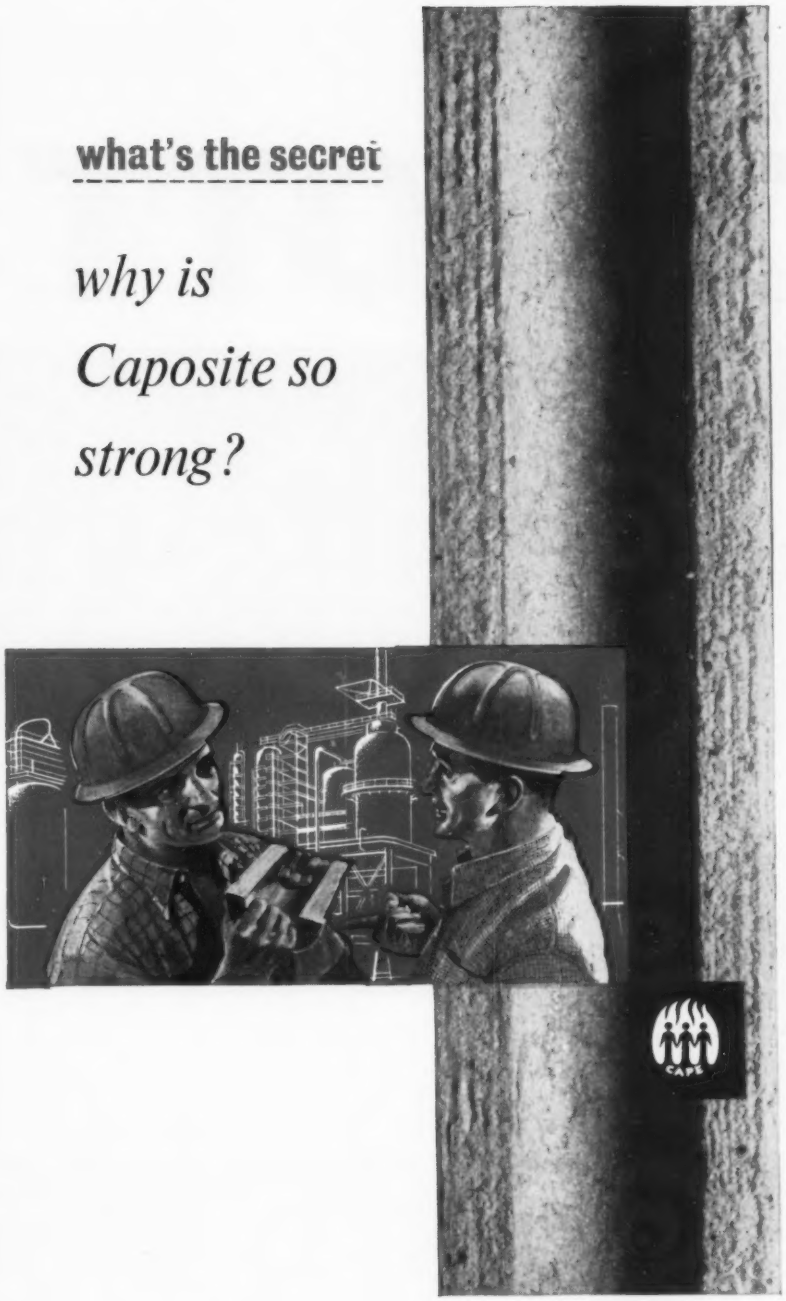
CANBERRA HOUSE, 315-7 REGENT ST. W.1.

Tel: LANGHAM 6526-7-8 Cables: Trivalon London Telex 24-100 Works: Lamberhead Green, Wigan, Lancs, England

Agents in: Holland · Belgium · Italy · W. Germany · Canada · Australia · Pakistan · Eire · Venezuela · France · Poland · Sweden · Finland · Norway

what's the secret

why is Caposite so strong?



It's no secret why CAPOSITE insulation is so strong and stands up to such rough usage. These pipe sections and blocks are made wholly of Amosite asbestos and the long fibres of this particular kind of asbestos give CAPOSITE its strength and resilience as well as its high insulating value. This exceptional strength leads to many other features besides long life; it means that larger sizes of pipe sections and blocks are possible, making application easier and faster. Less care is needed in handling the material. Unlike other moulded insulation, CAPOSITE, because of its strength, can be shipped to refineries anywhere in the world *in cardboard cartons*, showing big savings in freight and storage costs.

CAPOSITE Regd.

ASBESTOS INSULATION

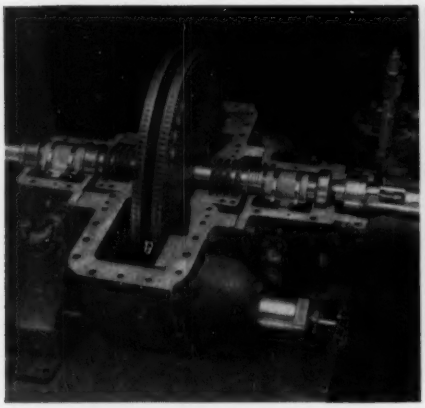
THE CAPE ASBESTOS COMPANY LIMITED, 114 & 116 PARK STREET, LONDON W1 Tel: Grosvenor 6022 Cables: Incorrupt London

Enquiries in Canada to: Cape Asbestos (Canada) Limited, 200 Bloor Street East, Toronto, Ontario
U.S.A.: North American Asbestos Corporation, Board of Trade Building, Chicago 4, Illinois

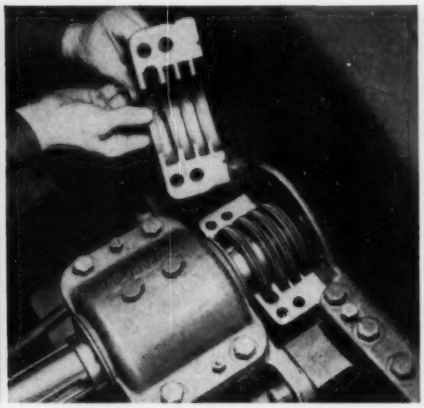
TA 10642

Economical in operation...
Dependable always

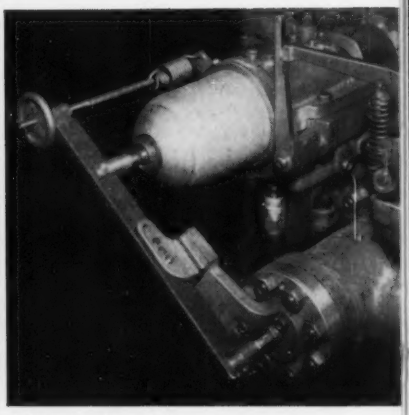
ELLIOTT



Precise alignment of shaft, through true centerline support, permits smooth and dependable operation at all operating temperatures. The entire rotor assembly is dynamically balanced.



Accessible shaft-seals simplify maintenance and routine inspection. Shaft surface under packing glands is stainless steel. Covers are readily removable without disturbing the upper-half casing.



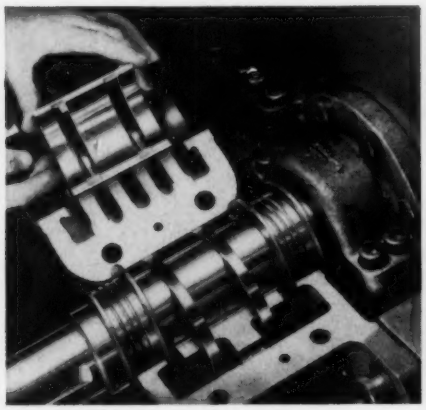
Simple, Positive direct-acting speed-governing system is dependable, weather-proof, accurate. Separate trip gives positive overspeed protection, and it may be easily reset against line pressure.

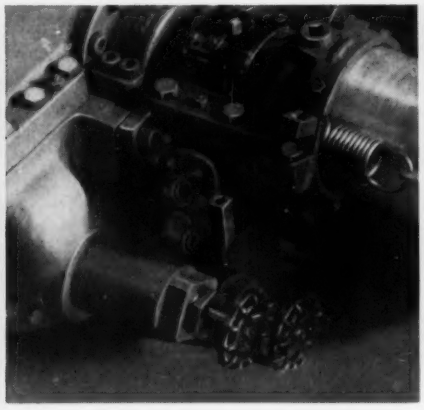
Only ELLIOTT Turbines give you all these PLUS features

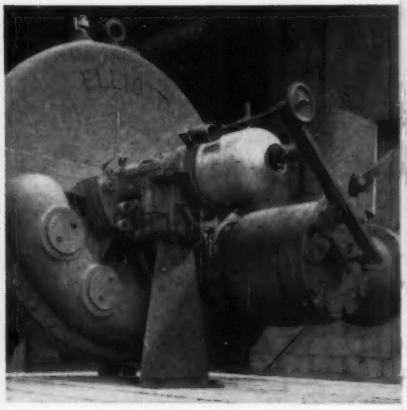
By separating the pedestal-mounted exhaust-end bearing from the hot turbine casing, the temperature distortion is minimized, and the vertical shaft movement is thereby eliminated.

Steam-saving hand valve with pilot, which can be opened against full steam pressure, reduces steam consumption at partial loads. This feature is available on all sizes of Elliott YR steam turbines.

All-weather protection is standard for Elliott YR turbines. They shrug off heat, dirt, snow, moisture or contaminated atmosphere. Stainless steel exposed parts are furnished for extreme conditions.

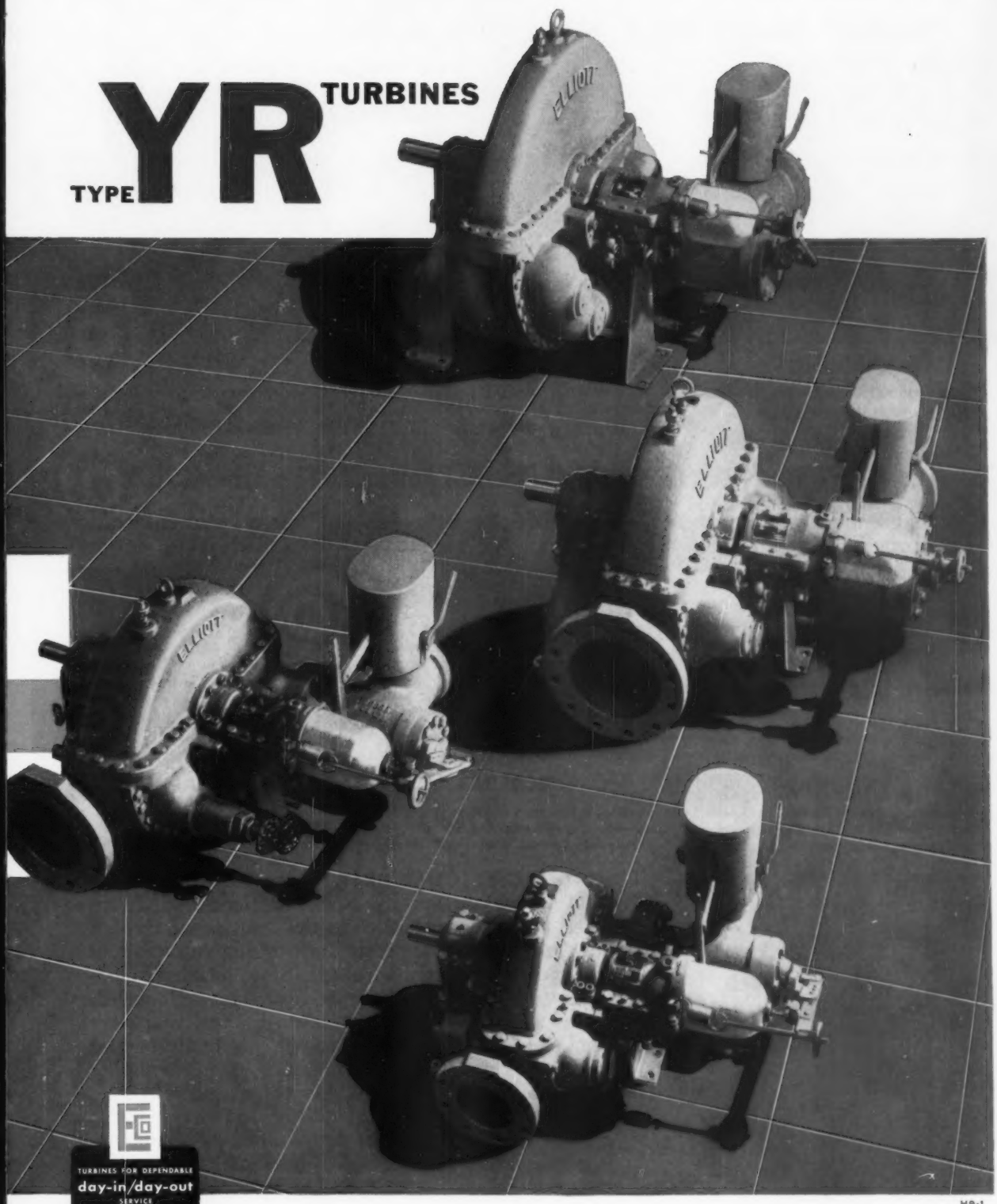






In addition to the units illustrated here, Elliott makes single-stage turbines in special frames, reduction gears, multistage mechanical drive turbines to 50,000 hp, and turbine-generators ranging through 44 mw.

TYPE **YR** TURBINES



TURBINES FOR DEPENDABLE
day-in/day-out
SERVICE

HB-1

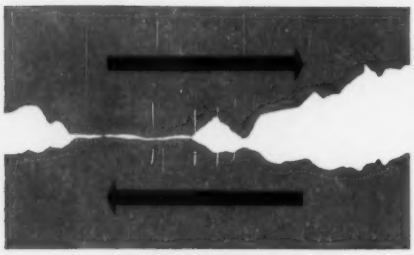
ELLIOTT Company JEANNETTE, PENNA.

For more data on advertised products, use Readers' Service Cards, last page.

WHY VALVE LUBRICATION SAVES MONEY

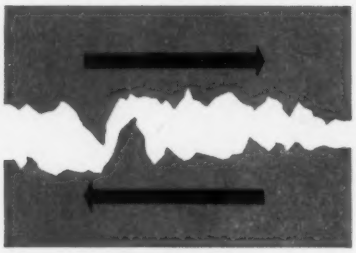
TROUBLE STARTS WHEN METAL RUBS METAL...

Under the microscope, metal that appears mirror-smooth to the naked eye shows as sharp mountains and deep valleys. This roughness, combined with the heat and pressure of metal-to-metal rubbing, causes valve trouble in the following ways:



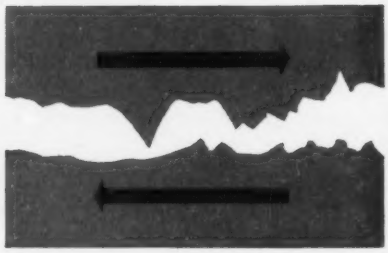
STICKING

"Cold Welding" occurs when friction or pressure welds the peaks together. The result: sticking.



SHEARING

The "hills" of one surface gouge into the hills of the other surface causing further sticking and scoring.

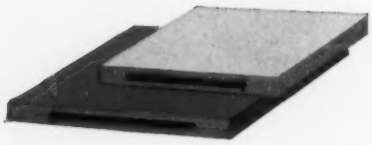


PLOWING

If one surface is even slightly harder than the other, the hard peaks act like a "plow". Leakage soon results.

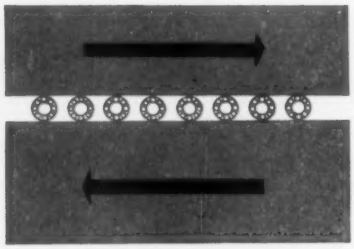
BUT, WITH ROCKWELL-NORDSTROM VALVE LUBRICATION...

metal-to-metal contact is eliminated. Here's what happens when metal-to-metal surfaces are lubricated:



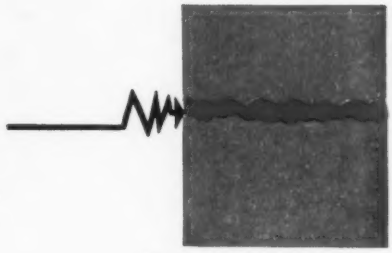
SLIDING

Lubricant prevents friction heat, eliminating danger of cold welding and assuring easy movement.



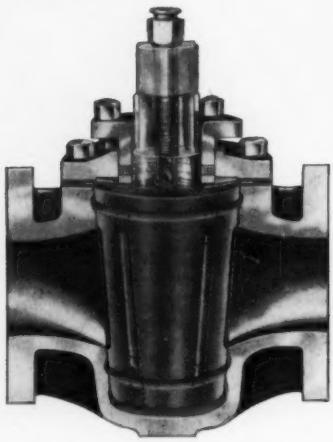
ROLLING

Lubricant becomes millions of tiny bearings . . . metal surfaces actually never come into contact with one another.



SEALING

Pressurized lubricant forms an impenetrable, continuous seal against leakage.



LONGER LIFE, LOWER COST, better valve service results when you specify Rockwell-Nordstrom lubricated plug valves. Notice in the drawing at the left how lubricant protects all the working surfaces and seals positively against leakage. Since lubricant eliminates adhesion, shearing and plowing, Rockwell-Nordstrom valves cost you less to use . . . year after year. Rockwell-Nordstrom valves are available in a complete range of sizes and pressure ratings to answer every flow control need. They cost no more to buy, often less, than ordinary valves. See your nearest supplier or write Rockwell Manufacturing Company, Pittsburgh 8, Pa. for complete details.

Canadian Valve Licensee: Peacock Brothers Limited

ROCKWELL-Nordstrom VALVES

it's ROCKWELL

MANUFACTURING COMPANY

BEFORE KONTOL! *Here's what a tube bundle looked like in one of the heat exchangers of an Ohio refinery — after just 94 days of service. A KONTOL Protection Program has since trebled tube life, upped heat exchange efficiency by more than six million BTU's per hour!*

another TRETOLITE SERVICE *report*

See our exhibit at the International Petroleum Exposition, Tulsa, May 14-23, and 5th World Petroleum Congress, New York, June 1-5.

KONTOL* CORROSION INHIBITOR TRIPLES TUBE-BUNDLE LIFE AT OHIO REFINERY

Also saves $96.00 per day on increased BTU's . . . The effectiveness of KONTOL* protection against corrosion and fouling in tube bundles was dramatically demonstrated in the heat exchange equipment of the crude unit at a large refinery in Ohio.

Since the inauguration of a regular KONTOL Corrosion Inhibitor program, the tube bundle life period has been increased by approximately 3 times the bundle life prior to the use of KONTOL.

KONTOL'S DETERGENT ACTION ADDS DOLLAR-BONUS TO OPERATION

The detergent action of KONTOL Corrosion Inhibitor provided a *plus* benefit for the refinery. A cleaner operation has resulted in the gain of an additional 6,000,000 BTU's per hour—or a savings of about $96.00 per day.

THERE'S A KONTOL PRODUCT FOR YOUR CORROSION PROBLEM

The KONTOL product used in this case was based on a careful study of the refinery's specific needs. The Tretolite Company developed and pioneered the application of organic corrosion inhibitors throughout the petroleum industry. No other organization has Tretolite's wealth of experience and know-how in the manufacture and use of these products. This background (Tretolite corrosion engineers, laboratory and research facilities) is always available to you—to help solve your particular corrosion problems. A call will bring you this service—at no obligation.

*KONTOL *is a registered trademark of Petrolite Corporation.*

KR-59-1

PETROLITE CORPORATION

TRETOLITE COMPANY
DIVISIONS
369 Marshall Avenue, Saint Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

CANADA: Petrolite Corporation of Canada, Limited, 309 Alexandra Bldg., Edmonton, Alberta

COLOMBIA: South American Petrolite Corporation, Calle 19, No. 7-30, Office 807, Bogota

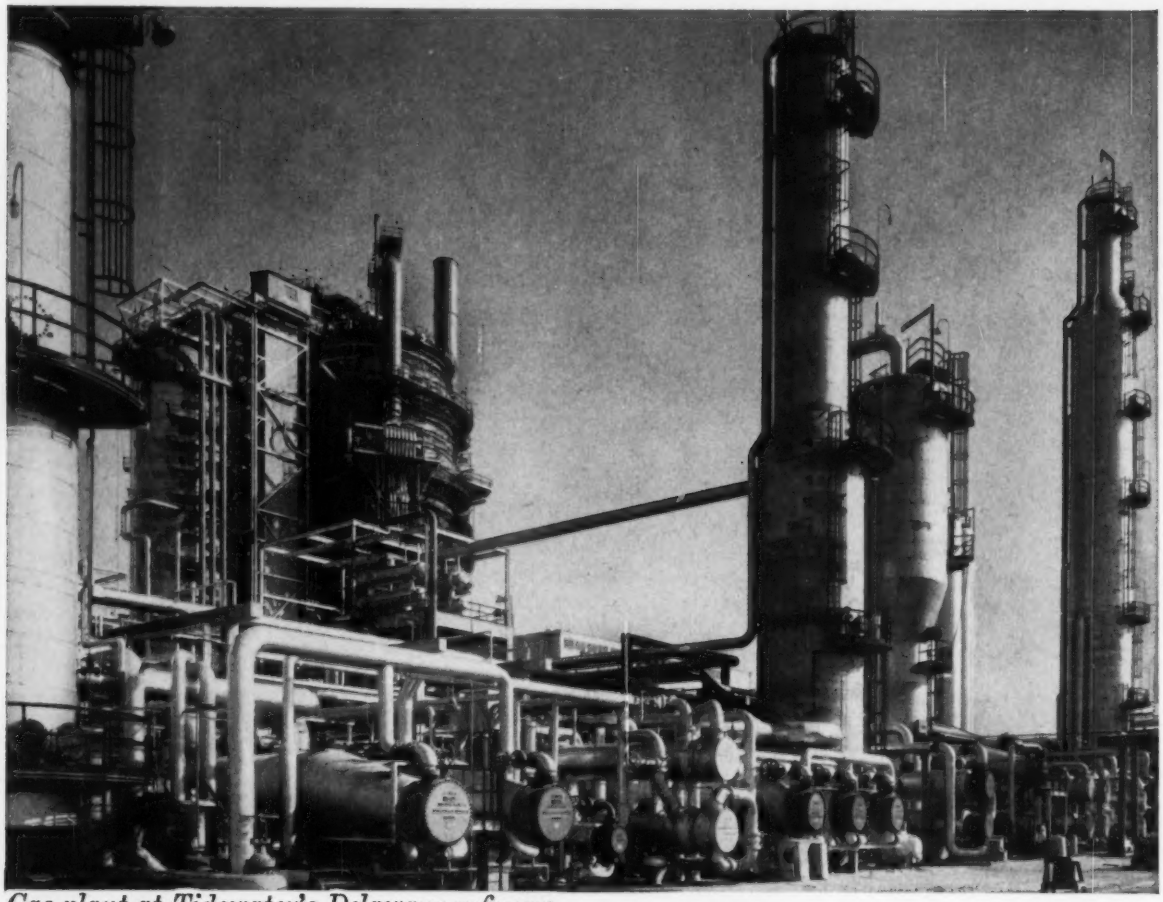
ENGLAND: Petrolite Limited, 46 Mount Street, London W. 1.

VENEZUELA: South American Petrolite Corporation, Hotel Avila, Caracas

REPRESENTATIVES

BRAZIL: WERCO, Ltda., Rua General Gurjao 326, Rio de Janeiro
GERMANY: H. Costenoble, Guiollettstrasse 47, Frankfort, a.M.
ITALY: NYMCO S.p.A. 9, Lungotevere A. da Brescia, Rome
JAPAN: Maruwa Bussan KK, No. 3, 2-Chome, Kyobashi, Chuo-Ku, Tokyo
KUWAIT: F. N. Dahdah, Box 1713, Al Kuwait
MEXICO: R. E. Power, Sierra de Mijes, No. 125, Mexico, D. F.
NETHERLANDS: F. E. C. Jenkins, Hoefbladlaan 134, The Hague
PERU: International Gas Lift Company, Apartado 71, Talara
TRINIDAD: Neal and Massy, Ltd., Port of Spain, P.O. Box 544

For more data on advertised products, use Readers' Service Cards, last page.



Gas plant at Tidewater's Delaware refinery...

Chromium-nickel stainless steels protect regenerator from H_2S and DEA corrosion

This centralized gas plant serves all of Tidewater Oil Company's new Delaware Refinery, and can treat 88 million cubic feet per day.

Its regenerator separates large amounts of hydrogen sulfide—introduced by the sour crudes handled—from hot diethanolamine (DEA).

Corrosion could have been a problem in this regenerator – especially in its upper section where hydrogen sulfide concentration is high, DEA concentration is low. However, during planning, Tidewater's engineers considered previous operating experience, and with C. F. Braun & Co., job engineers, made detailed investigations of likely trouble points. As a result, Types 347 & 316 chromium-nickel stainless steels were specified for the regenerator.

Nickel-containing stainless steels in other units...

This modern refinery is designed with emphasis on continuous operation of large, single units. Nickel-containing stainless alloys guard against corrosion failure at many points: crude unit columns, parts of the fluid coker, hydrogen plant, cooling water system, many pumps and lines.

For more information, send for "Corrosion Resisting Properties of Chromium-Nickel Stainless Steels." And for assistance with a corrosion engineering problem, write Inco's Development and Research Division. They'll be glad to work with you and help find a solution.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

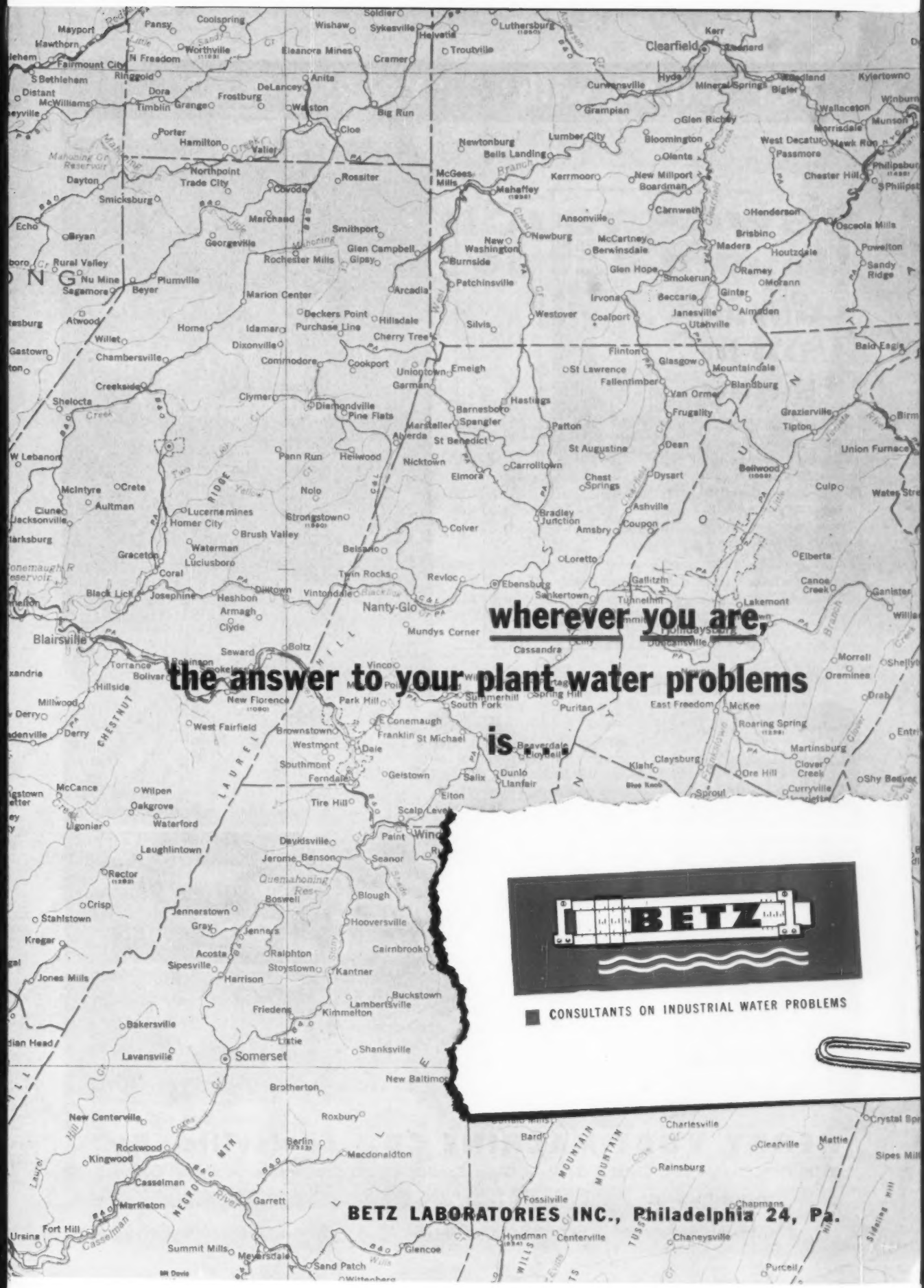
Here's where chromium-nickel stainless steels are used to combat corrosion by H_2S and DEA in regenerator of gas unit at Tidewater's Delaware Refinery.

Equipment	Location	Material
Regenerator shell	Cladding above tray #14	Type 347 Stainless Steel
Regenerator trays	Trays #14 to #18	"
Reflux accumulator	Clad inside surface	"
Reflux accumulator pump	Impeller and casing	"
Piping	Regenerator O.H. to accumulator	Type 316 Stainless Steel
"	Reflux accumulator to regenerator	"

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

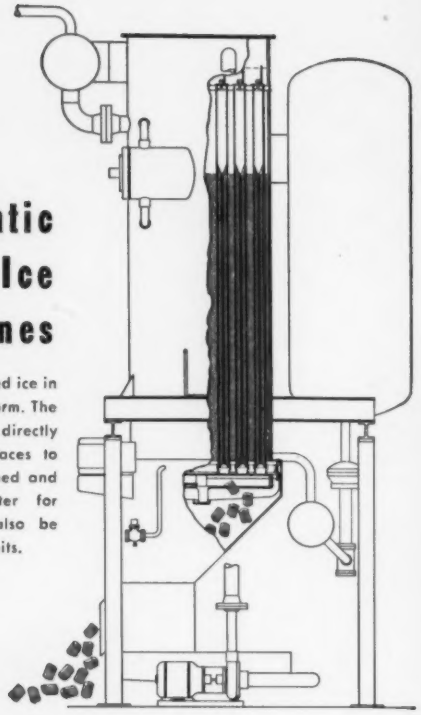
For more data on advertised products, use Readers' Service Cards, last page.


wherever you are,
the answer to your plant water problems
is . . .
BETZ
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS
BETZ LABORATORIES INC., Philadelphia 24, Pa.

GET AHEAD with . . . "YEARS-AHEAD" . . .

Automatic Tube-Ice Machines

Make clear, hard, sized ice in cylinder or crushed form. The refrigerant is applied directly to the freezing surfaces to produce ice with speed and economy. Cold water for process work can also be supplied by these units.



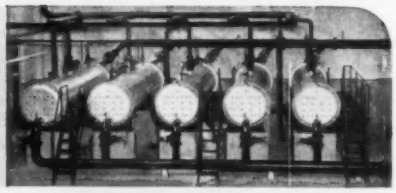
Vogt

ICE MAKING and REFRIGERATING EQUIPMENT

. . . for the preservation of foods and beverages during process and in storage. Petroleum refineries, chemical plants, and related industries also employ this equipment in various processes. In addition to equipment shown here, we manufacture liquid receivers, pipe coils, and valves, fittings, and flanges, for refrigeration as well as for high pressures and temperatures. Bulletins on request. Address Dept. 24A-RIPR.

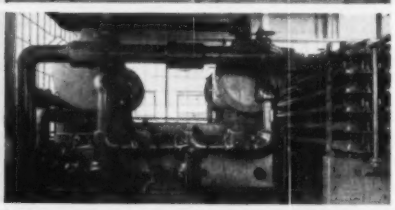
Refrigeration Condensers

Available in horizontal multipass shell and tube types and vertical single pass types for Ammonia or other refrigerants. Special metals, lined tubes, etc. can be furnished for unusual operating conditions.



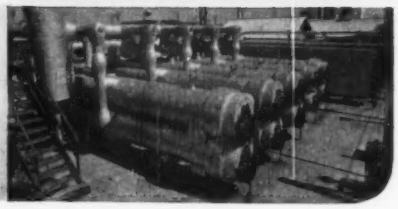
Brine Coolers

Multipass type brine coolers are ideal for closed brine systems in cold storage plants, dairies, packing plants, petroleum refineries, etc. requiring units of large capacity. Also suitable for cooling non-corrosive liquids in general.



Scraped Surface Exchangers

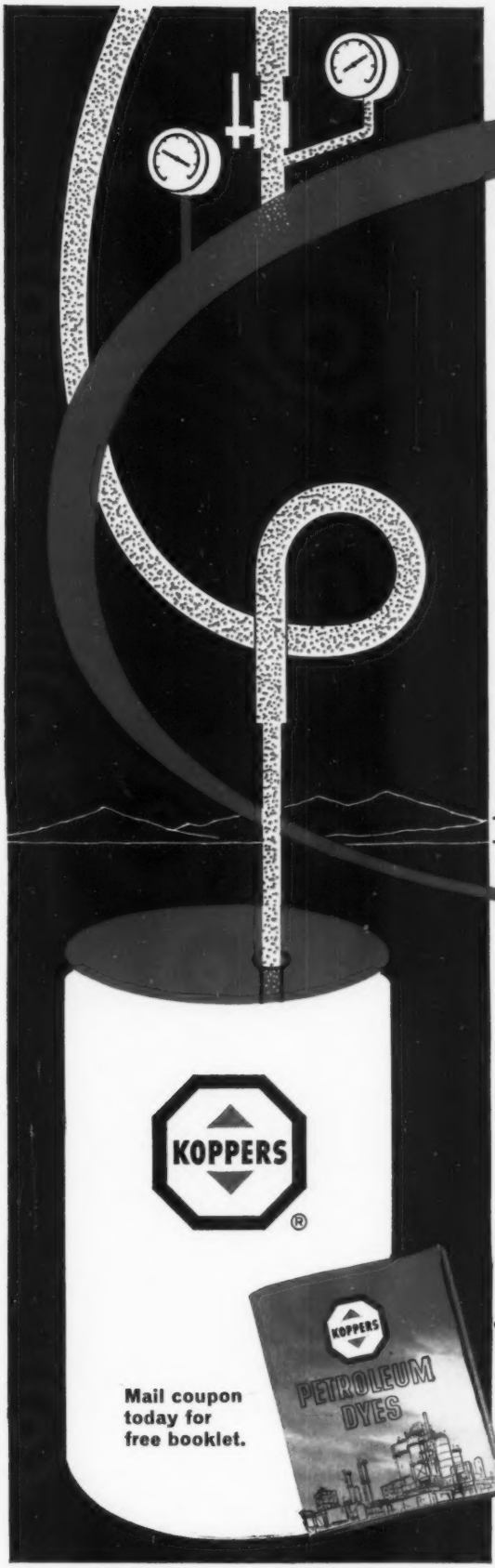
Continuously revolving scrapers sweep heat transfer surfaces clean and keep solids in suspension. Useful in problems of heat transfer with crystallization with high viscosity, or with solvent extraction. Available in double pipe and shell and pipe construction.



HENRY VOGT MACHINE CO., Louisville, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati

OTHER VOGT PRODUCTS DROP FORGED STEEL VALVES, FITTINGS AND FLANGES IN A COMPLETE RANGE OF SIZES • PETROLEUM REFINERY AND CHEMICAL PLANT EQUIPMENT • STEAM GENERATORS

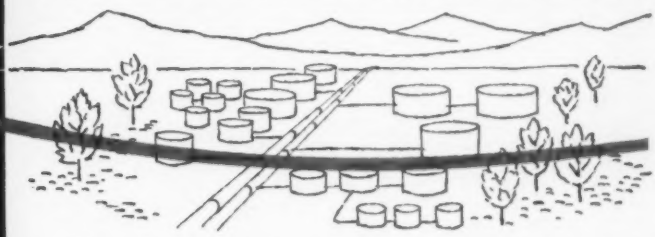


COLORPOWER on the move!

NEW *Free-Flowing* GRAN-U-FLOW Dyes refuse to cake or clog ...and are dustless, too!

Now—for the petroleum industry . . . Koppers new Gran-U-Flow dyes for use in eduction systems keep your "colorpower" on stream. These dust-free dyes possess unique free-flowing properties that provide uniform feed rate for fast and smooth dispersion. The well-known Koppers standard for unvarying batch-to-batch uniformity and top tinctorial value has been vigilantly maintained.

Two convenient features, added to all Koppers drums, greatly facilitate their use. Every drum head contains a plastic plug colored to denote the dye content. In addition, a New Vu-Dye Top enables the operator full-view control of drum contents and eliminates dusting. Both drum head and Vu-Dye Top are made to accommodate Koppers new eduction probe.



Our sales engineers are always available to provide you with complete information and ready technical assistance. Simply get in touch with our nearest branch office for quick, responsive service.

KOPPERS COMPANY, INC.

Chemicals and Dyestuffs Division

KOPPERS BUILDING, PITTSBURGH 19, PA. • **Plant:** Lock Haven, Pa.
Branches: Providence, R. I. • Philadelphia, Pa. • Paterson, N. J. • Chicago, Ill. Charlotte, N. C. • Chattanooga, Tenn. • Columbus, Ga. • Los Angeles, Calif. Houston, Texas • **Dominion Anilines & Chemicals, Ltd.,** Toronto, Canada

Please send me a free copy of the new Koppers Petroleum Dye booklet.

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

Mail to our Pittsburgh office or nearest branch.

FOXBORO d/p CELL

unequaled –

Simplest installation — orifice flange tap connections at standard spacing, are provided at both ends.

Drain and vent holes at lowest and highest points on both sides.

Purged cover protects transmitter from weather, dust, and fumes.

Over 60,000 now in use!

No zero drift . . . positive overrange protection . . . high sustained accuracy even under the most punishing operating conditions. No wonder over 60,000 Foxboro d/p Cell Transmitters have been installed since they were introduced in 1948.

By introducing the modern concept of high speed flow measurement and control, these differential pressure transmitters have *revolutionized* many an industrial process. Bulletin 13-11A shows how — and portrays the benefits the d/p Cell Transmitter offers you. Write The Foxboro Company, 742 Neponset Ave., Foxboro, Mass., U.S.A.

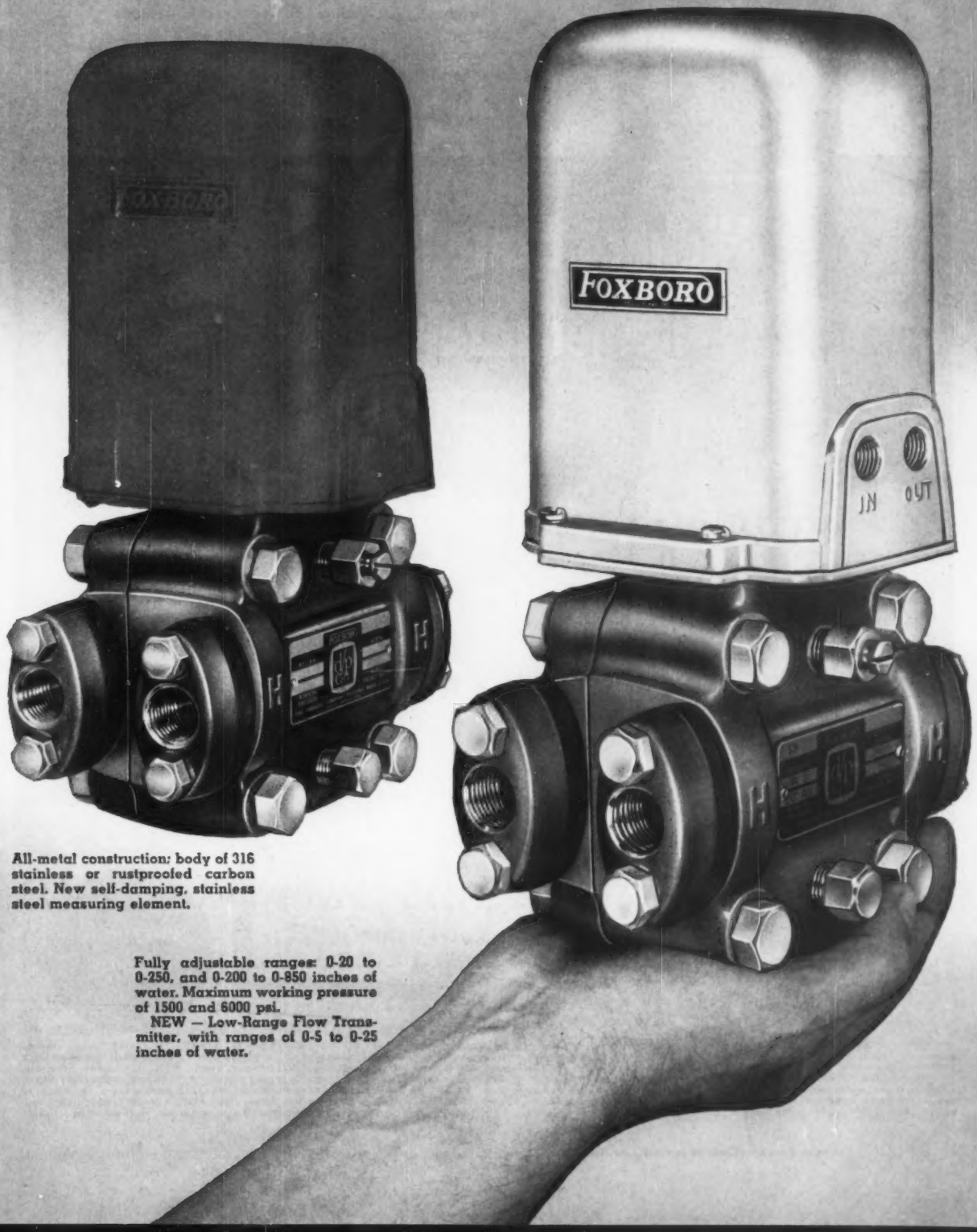
FOXBORO

REG. U.S. PAT. OFF.

FIRST in Flow Measurement and Control

FLOW TRANSMITTERS...

in accuracy, stability and performance



All-metal construction: body of 316 stainless or rustproofed carbon steel. New self-damping, stainless steel measuring element.

Fully adjustable ranges: 0-20 to 0-250, and 0-200 to 0-850 inches of water. Maximum working pressure of 1500 and 6000 psi.

NEW — Low-Range Flow Transmitter, with ranges of 0-5 to 0-25 inches of water.

If you have the problem of increasing octane rating and production in your existing equipment, investigate the unique performance of Sinclair-Baker RD 150 Platinum Reforming Catalyst. Its efficiency in producing *important yield increases at high octane levels* is a matter of record. The long period of RD 150 operation is unmatched by any other catalyst . . . further, *it is regenerative in situ!* Cost is sharply reduced to lowest level.

Higher octane levels and longer catalyst life...

with existing equipment

...merely by replacing with

Sinclair-Baker RD 150

Platinum Catalyst

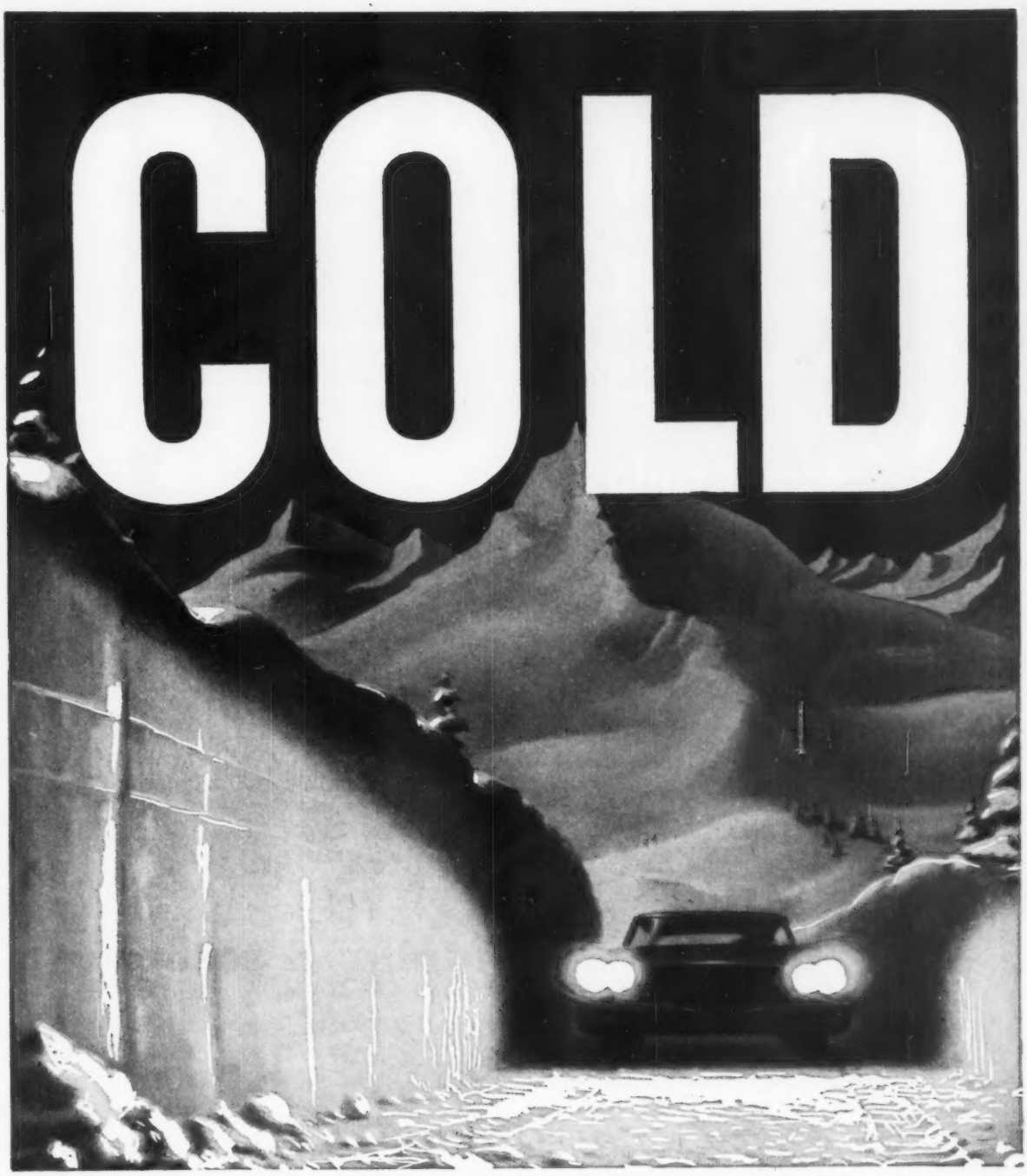
ENGELHARD INDUSTRIES, INC.

EXECUTIVE OFFICES:

113 ASTOR STREET • NEWARK 2, NEW JERSEY

CHEMICAL DIVISION

DOMESTIC DIVISIONS: AMERICAN PLATINUM & SILVER DIVISION, AMERSIL QUARTZ DIVISION, BAKER CONTACT DIVISION, BAKER DENTAL DIVISION, BAKER SETTING DIVISION, BAKER PLATINUM DIVISION, CHEMICAL DIVISION, EAST NEWARK INDUSTRIAL CENTER, HANOVIA LAMP DIVISION, HANOVIA LIQUID GOLD DIVISION, IRVINGTON-BAKER REFINING DIVISION, D. E. MAKEPEACE DIVISION, NATIONAL ELECTRIC INSTRUMENT DIVISION, RESEARCH AND DEVELOPMENT DIVISION, H. A. WILSON DIVISION. COMPANIES ABROAD: ENGELHARD INDUSTRIES OF CANADA, LTD. TORONTO, ENGELHARD INDUSTRIES OF QUEBEC, LTD. MONTREAL, ENGELHARD INDUSTRIES, LTD. LONDON, ENGELHARD INDUSTRIES A. G. ZURICH, ENGELHARD INDUSTRIES PTY., LTD. MELBOURNE, SOCIEDAD SURAMERICANA DE METALES PRECIOSOS S. A. BOGOTA, INDUSTRIE ENGELHARD S. P. A. ROME, ENGELHARD INDUSTRIES OF SOUTHERN AFRICA, LTD. JOHANNESBURG. ASSOCIATED COMPANIES: ACME TIMBER INDUSTRIES LTD., SOUTH AFRICAN FOREST INVESTMENTS LTD., SOUTH AFRICA, AZOPLATE CORPORATION, CHARLES ENGELHARD, INC., NUCLEAR CORP. OF AMERICA, INC., U.S.A.



OR HOT... PARATONE-BLENDED OILS DO THE JOB!

Driving conditions—whether in sub zero temperatures—or in blazing summer heat, demand the most from lubricating oils. Oils blended with Enjay Paratone® viscosity index improver remain free flowing all winter long—and provide instant lubrication when starting up. And yet when engine temperatures soar, these same Paratone-blended oils stand up and refuse to thin out.

Enjay has developed the only complete line of high quality additives (Paramins®). To meet the most exacting lubrication specifications, insist on Enjay Paramins.

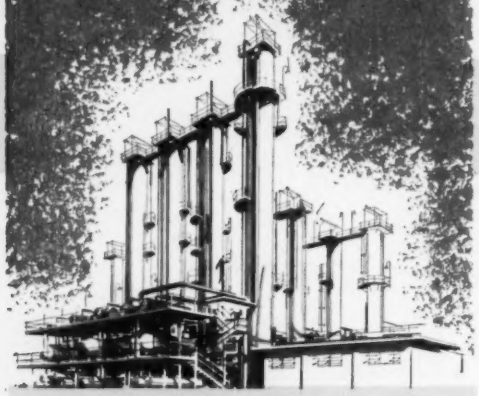
ENJAY

Pioneer in Petrochemicals

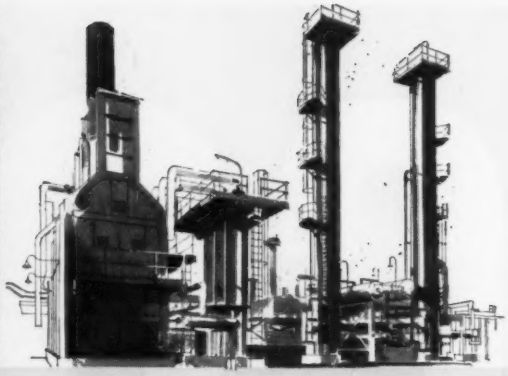
ENJAY COMPANY, INC., 15 West 51st St., New York 19, N. Y. • Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

For more data on advertised products, use Readers' Service Cards, last page.

Now any refiner can process any crude he wants...



UDEX® the ideal process for separation of super-purity aromatics



PLATFORMING® produces high octane gasolines, high purity aromatics

HF ALKYLATION makes alkylate, top anti-rumble motor fuel

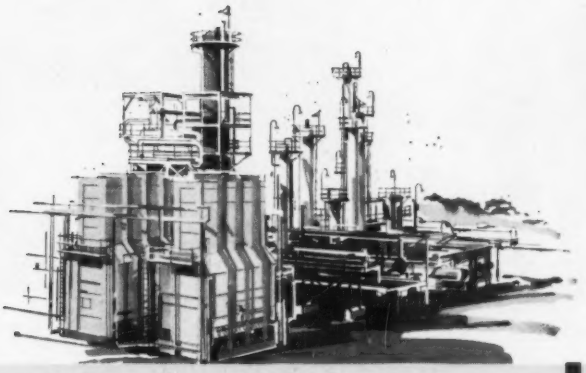
other

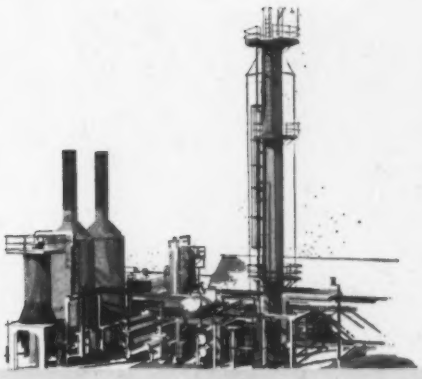
Never before could the petroleum refiner accomplish what he can today. Regardless of the sources and nature of his crude supply—or the kind of petroleum or petrochemical products he wishes to produce—Universal can furnish invaluable aid in helping achieve his objectives.

From its nineteen different processes currently available, Universal is in an unparalleled position to provide you with technical knowhow. From analysis of product and market potentials and evaluation of crude supplies through to process design, engineering, operator training and field and laboratory service, UOP is equipped and ready to work with you every step of the way.

Write for information. Consultation is invited on any processing problem.

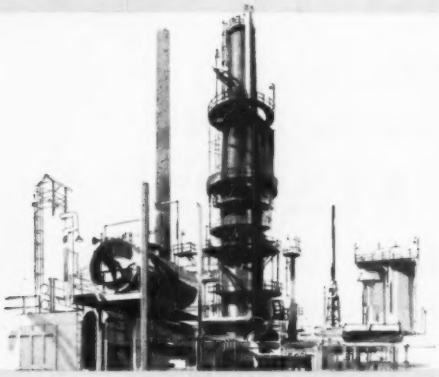
For more data on advertised products, use Readers' Service Cards, last page.

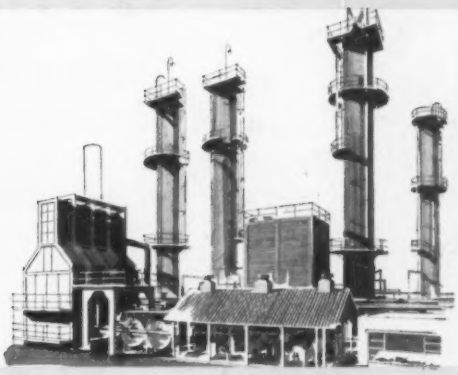




BUTAMER* a new and practical process for producing isobutane

UNIFINING* a modern process that completely purifies petroleum distillates





FLUID CATALYTIC CRACKING an improved process that gives higher yields, higher octane numbers

PENEX* new process converting light, normal paraffins to isoparaffins

processes available from UOP

REXFORMING®
the ideal process to insure your top octane position

UNISOL®
a safe and economical process for low-cost gasoline finishing

VACUUM DISTILLATION and VISBREAKING
simple, easy to operate processes for preparation of feed stocks for catalytic cracking

L. P. COKING
permits adjustment of gasoline-to-heavy oils production ratio to meet market needs

THERMAL CRACKING
two-coil selective process, handles wide range of charging stocks

CATALYTIC CONDENSATION
converts olefin fractions of refinery gas into high-quality gasoline and petrochemicals

OLEFIN EXTRACTION
efficiently separates olefins and diolefins from paraffins. Also prepares olefins for further conversion

CATALYTIC DEHYDROGENATION
removes hydrogen from hydrocarbons to produce less saturated hydrocarbons

HYDRAR*
converts benzene to cyclohexane with excellent yields. Extreme high purity achieved with Udex grade benzene

AROSORB
removes heavier aromatics from synthetic and natural distillates, produces aromatic-free heavier distillates

ALKAR*
produces ethylbenzene, cumene and other alkylated aromatics from Fluid Catalytic Cracker off-gas streams

SULFURIC ACID ALKYLATION
produces alkylate, blending component for high-octane gasoline

*TRADEMARKS

UOP® UNIVERSAL OIL PRODUCTS COMPANY
30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U. S. A.
More Than Forty Years Of Leadership In Petroleum Refining Technology

For more data on advertised products, use Readers' Service Cards, last page.

Badger's answer to the "who?"
in your engineering/construction contract:

the Key Man

Badger Key Man Service saves time, money — and eliminates frustration — in the engineering and construction of process plants. The Key Man is *both* an experienced engineer and a principal of Badger. He coordinates and administrates *all* project activities — from first negotiations to "on stream." He is prepared and qualified to make policy decisions.

This is engineering service at its best. And it is one reason why Badger — and Badger clients — are so successful. Write, wire or phone for full information. Badger Manufacturing Company, 230 Bent Street, Cambridge, Massachusetts.

built by **BADGER**

DESIGNERS • ENGINEERS • CONSTRUCTORS • MANUFACTURERS

OFFICES AND SUBSIDIARIES IN NEW YORK • HOUSTON • TORONTO
LONDON • THE HAGUE • BRUSSELS

ALUMINUM GATE VALVES

BY DARLING

FEATURING:

unmatched advantages of DARLING fully revolving double disc parallel seat gate valve principle!

There's new economy to be gained in the handling of "problem" fluids and gases with Darling aluminum alloy gate valves . . . now available in ½" through 24" sizes. We have data on initial and long-range costs and performance that will interest you. Write for facts.

DARLING VALVE & MANUFACTURING CO.

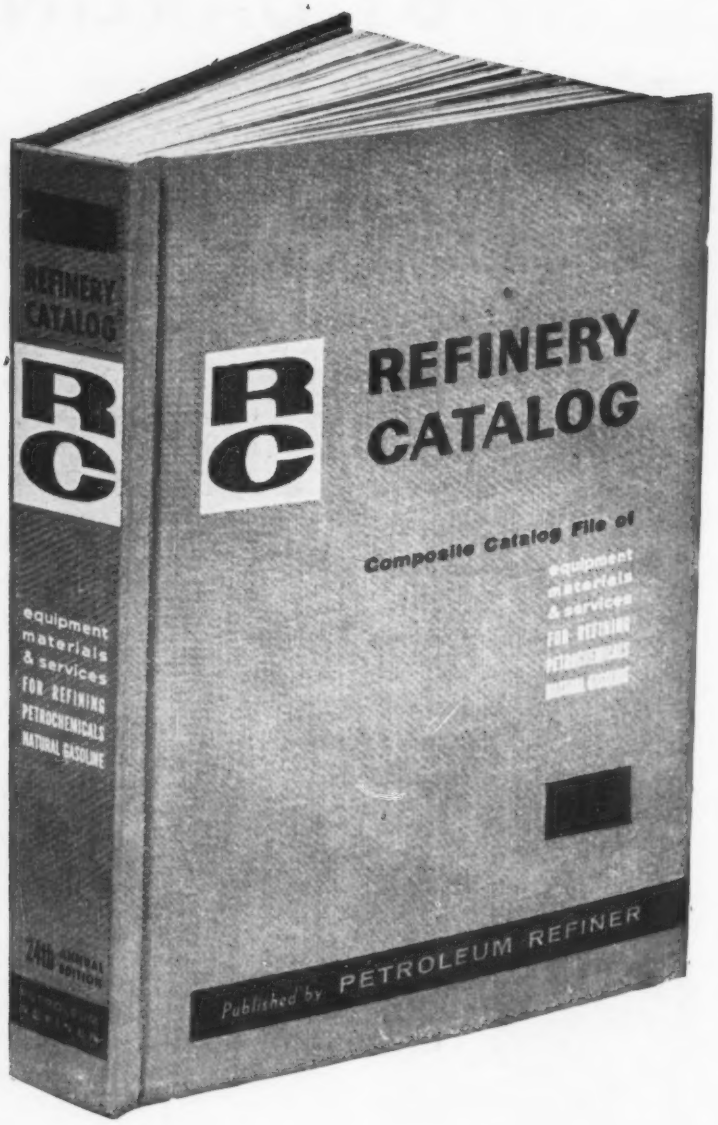
Williamsport 31, Pa.

For more data on advertised products, use Readers' Service Cards, last page.

NOW

BETTER THAN EVER

The REFINERY CATALOG's current edition is better, more complete than ever before.



For more data on advertised products, use Readers' Service Cards, last page.

MOST COMPLETE SINGLE SOURCE

..... of Equipment-Service Data in

– Refining

– Natural Gasoline

– Petrochemicals

Completely indexed and cross indexed . . . Saves Time
Refer to it when ordering . . . specifying . . . inquiring

Make your buying job easier, eliminate errors, reach for your copy of the REFINERY CATALOG and watch for quick, efficient results.

More Complete and Useful Than Ever

The REFINERY CATALOG is an indispensable tool, more valuable and useful this year than ever before. Here's part of what you'll find in it!

★ Complete or condensed catalogs of hundreds of manufacturers, service companies, and suppliers serving the industry.

★ Authoritative, up-to-date specifications and data.

★ Local sources of supply.

★ Convenient alphabetical index of manufacturers and a classified index of equipment, materials and services.

The REFINERY CATALOG

Published annually by PETROLEUM REFINER, Gulf Publishing Company

P. O. BOX 2608 • HOUSTON, TEXAS, U. S. A.

For more data on advertised products, use Readers' Service Cards, last page.

MAJOR SOURCE OF MAJOR ACIDS

SULFURIC ACID

Commercial Grades of 77.67 to 122.5% H_2SO_4. *"Special Grade"* concentrations of 93 to 100% H_2SO_4 with iron guaranteed less than 50 ppm and similarly low content of nitrogen, arsenic and other impurities. *Electrolyte Quality* at Sp.Gr. 1.300, 1.360, 1.400, 1.500 and 1.835. *Oleum* in all concentrations from 15% free SO_3 to 100% Liquid SO_3 (equivalent to 103.38 to 122.5% H_2SO_4). *Regenerated* Acid sludges are decomposed, regenerated and delivered as water-white 98% H_2SO_4 on an established contract basis. *Spent Acids* from the manufacture of white oils, fuels, chlorine gas, alcohols, DDT, butadiene and other products are recovered, regenerated or fortified for re-use at the source or for different use. In any case, Stauffer processing and contract arrangements eliminate waste, eliminate air and stream pollution or the alternative of in-plant conversion of process residues.

MURIATIC ACID

Delivered in standard strengths of 18°, 20° and 22° Bé corresponding to 27.92, 31.45 and 35.21% HCl. Stauffer also offers an extremely high-purity, high-analysis grade of muriatic acid for special uses. All grades are available in tank cars, tank trucks and carboys.

NITRIC ACID

Commercial Grades of 38°, 40° and 42° Bé corresponding to 56.52, 61.38 and 67.18% HNO_3. *Engravers' Quality* of the same concentrations is conditioned to prevent fuming and discoloration of etching plates.

HYDROFLUORIC ACID

Anhydrous, is shipped in 22-ton and 42-ton tank cars, and in 100- and 200-pound cylinders from the Nyotex Chemicals Division of Stauffer Chemical Company at Houston; aqueous acid from the Stauffer plant at Louisville, Ky.

80 YEARS OF SERVICE TO INDUSTRY

testify to Stauffer Chemical Company's reliability as a major source of volume acids and an authoritative source of information on their use and handling.

STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, New York
636 California Street, San Francisco 8, California
Consolidated Chemical Division: 6910 Fannin Street, Houston, Texas

Stauffer's Sulfuric Acid is shipped from Mobile, Ala., Los Angeles and Richmond, Cal., Hammond, Ind., Baton Rouge, La., Baytown, Fort Worth and Houston, Tex., and various stock points. Hydrochloric Acid is shipped from Richmond, Cal., and Fort Worth; Hydrofluoric Acid (anhydrous) from Houston; (aqueous) from Louisville.

For more data on advertised products, use Readers' Service Cards, last page.

Instrument Monitors Corrosion Rates While Equipment Stays on Line

Fastest Known Corrosion Rate Measurement

The *Corrosometer* is its name. It proves the effectiveness of Nalco refinery stream corrosion inhibitors . . . in a hurry. It is the fastest known method of determining corrosion rates in operating equipment; manufactured by Crest Instrument Co. under license from Standard Oil Company (Indiana), and distributed worldwide, by Nalco.

Corrosometer readings are taken quickly and accurately, indoors or out. Instrument leads are attached to probes mounted in corrosion trouble spots. One instrument serves virtually any number of probes.

Coupons, Inspections are Slower

Determining corrosion rates by loss-in-weight methods, using coupons inserted in lines, is a much slower process. Valuable in determining average corrosion rates, it lacks the speed that enables the Corrosometer to reveal immediately any change in corrosion rate caused by process variations. Nalco Representatives, as well as Nalco Corrosion Inhibitor customers and prospects, welcome the speed with which the Corrosometer delivers accurate corrosion rate readings as a real contribution to time and money-saving establishment of good corrosion control practices.

Corrosometer Can Show Day-to-Day Corrosion Rates in System

Readings taken with the Corrosometer show the corrosion rate in the system for a predetermined interval of time. The interval may be as long as desired—or as short as a day or less. Thus checks of Nalco treatment effectiveness, as well as prompt detection of unexpected increases in corrosivity, are practical and accurate with the Corrosometer.

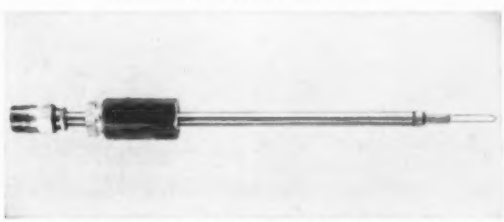
How Corrosometer Works . . .

Utilizing the Kelvin electrical bridge circuit, the Corrosometer compares resistances of two similar probes: one protected from corrosion, the other directly in contact with the liquid or gas in the equipment under test. Corrosion of the unprotected probe increases its electrical resistance, and the difference between probe resistances is directly convertible to corrosion-rate readings of high accuracy.

Retractable probes, for easy replacement without shutting down the system, and probes for high temperature and high pressure systems make the Corrosometer a valuable tool in checking Nalco Results in all types of corrosion-prone equipment.

Your Nalco Representative can give you full details on both the Corrosometer and Nalco corrosion inhibitors. Call him today — or write for descriptive literature.

Refinery Corrosion Probe



Retractable probe can be installed through a gate valve; replaced quickly without taking equipment off line.

NATIONAL ALUMINATE CORPORATION

6259 W. 66th Place • Chicago 38, Illinois

Branches and affiliates in Canada, Germany, Italy and Spain.

Nalco® **Serving Industry through Practical Applied Science**

Nalco CHEMICALS

For more data on advertised products, use Readers' Service Cards, last page.

STRONG as steel pipe

... at one-eighth the weight!

Circumferential Tensile Strength ... 80,000 psi

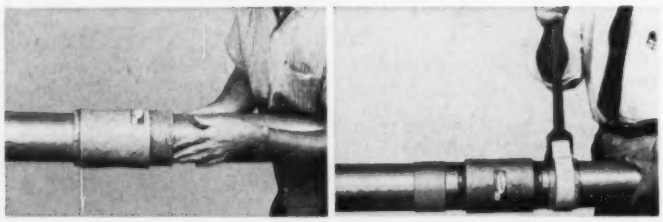
BONDSTRAND®

the revolutionary fiber glass reinforced epoxy pipe for corrosive service

114

Here's a pipe that holds up indefinitely under the corrosive action of many salt, acid and alkaline solutions ... that can't contaminate or flavor the piped material ... that is rigid enough to resist sag, cold flow or deformation – flexible enough to follow normal ditch contours ... that remains smooth and unclogged throughout its entire service life ... that won't leak, even near its burst pressure.

Easy to install, with choice of locking wedge or threaded fittings.



Simple instructions with each shipment insure a perfect joint on the first try.

IN THE PETROLEUM INDUSTRY...

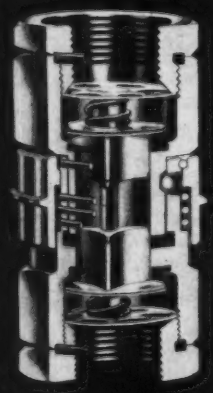
Consider BONDSTRAND for gathering, salt water disposal, offshore pumping and tanker loading lines; and for cooling towers, tank vents and gaging tubes. It won't corrode inside or out ... won't pick up paraffin or gypsum ... and is unaffected by petroleum products, hydrogen sulfide, fresh and salt water, and problem soil conditions.

Amercoat® CORPORATION

Dept. VB • 4809 Firestone Boulevard • South Gate, California

921 Pitner Avenue, Evanston, Illinois
360 Carnegie Avenue, Kenilworth, New Jersey
2404 Dennis Street, Jacksonville, Florida
6530 Supply Row, Houston, Texas

A Subsidiary of American Pipe & Construction Company



Provided with valves to give two-way or one-way automatic line shut off.

Built to handle high pressure in hydraulic and air systems.

Snap-Tite couplings stop the flow instantly"

Snap-Tite provides instant shut-off wherever fluid coupling is needed.

Snap-Tite couplings connect and disconnect quickly and fully—they automatically open line flow when connected; positively seal your line when disconnected—with no "ifs", no chance for human error.

Snap-Tite couplings are available in sizes from ¼" to 10" ID in all machinable metals. For more information, write for Snap-Tite catalog and, if you wish, describe your problem. Your local Snap-Tite representative will be glad to advise you.

SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS

★ Snap-Tite

SNAP-TITE, INC. • UNION CITY, PA.

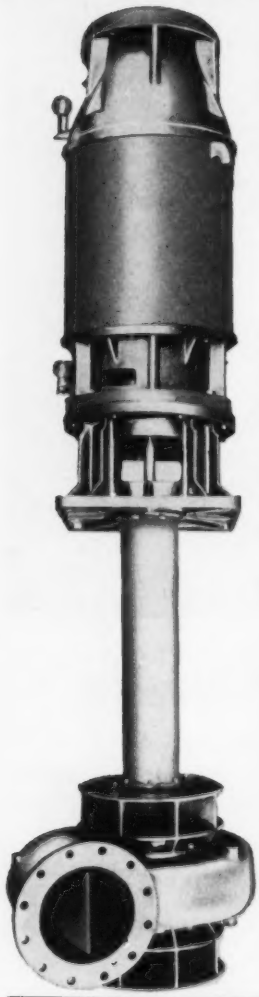
57-59-01

For more data on advertised products, use Readers' Service Cards, last page.

Bingham

TYPE "VS" DOUBLE SUCTION DOUBLE VOLUTE VERTICAL PUMP

REDUCES COSTS WITH SHALLOW PIT LOWER MAINTENANCE



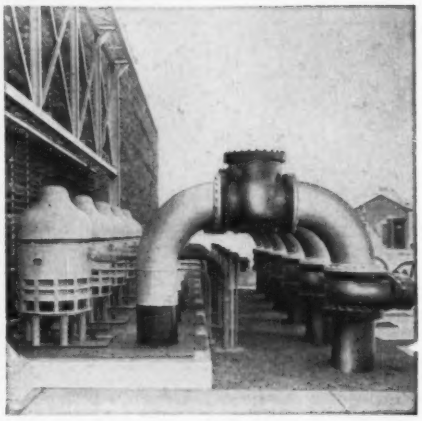
SPECIALLY DESIGNED FOR WET-PIT SERVICES. COOLING TOWER, SPRAY POND, DISPOSAL SUMP, WATER SUPPLY, DRAINAGE — AND OTHER HIGH-CAPACITY, MEDIUM-HEAD WET-PIT SERVICES.

The BINGHAM "VS" Pump, which is an advanced design of a "Double Volute"—"Double Suction" single stage pump, saves money in three ways: (1) Lower installed cost because it does not require a deep pit and can use standard motors. (2) Lower operating cost, because it operates at higher efficiencies, uses less power. (3) Lower maintenance cost, because there is no stuffingbox, all bearing loads are light, and the installation is easy to inspect and service.

The "Double Volute" construction of the "VS" Pump maintains radial balance of its rotating element throughout the entire operating range of the pump. Wear due to "Side Push" is eliminated.

The "Double Suction" feature of this pump eliminates axial hydraulic thrust, thereby permitting the use of standard vertical motors.

These and many other important reasons make the BINGHAM "VS" Pump the most logical choice today for wet pit service. For full details call your nearest Bingham Office or write for Bulletin No. 110.

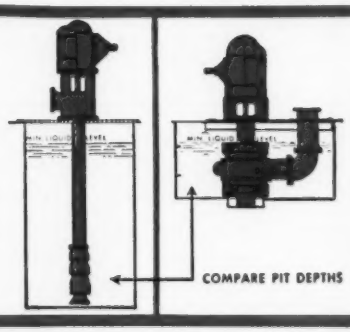


A Battery of Bingham "VS" Pumps Operating at a major Gulf Coast gas processing plant.

COMPARE THESE PITS FOR COST

OLD

Conventional Deep-Well Turbine Pump Installation . . . requires the pit be deep enough to maintain sufficient pumpage above the pumping element in order to provide the required NPSH.



NEW

Bingham "VS" Pump Installation . . . requires only a shallow pit and only sufficient pumpage to cover the pumping elements. Pit construction is thereby *greatly reduced.*

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

General Offices: **2800 N.W. Front Avenue, Portland 10, Oregon**

Factories: **Portland, Ore. • Vancouver, B. C., Canada**

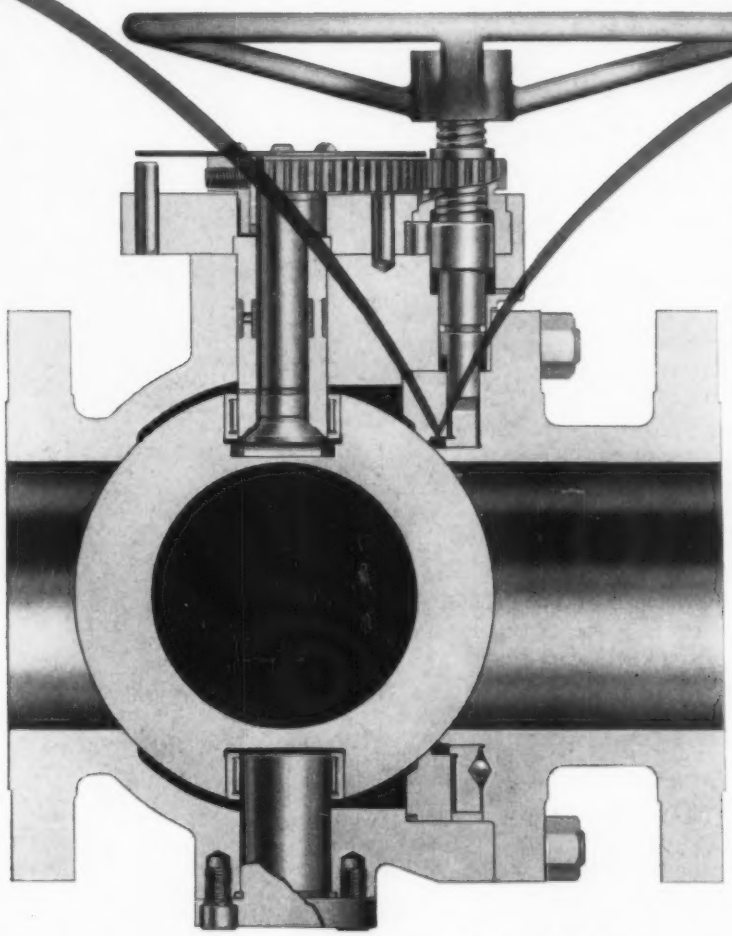
SALES AND SERVICE OFFICES

BOSTON, MASS.
CHICAGO, ILL.
CLEVELAND, OHIO
DALLAS, TEXAS
DENVER, COLO.
HOUSTON, TEXAS
KANSAS CITY, MO.
LOS ANGELES, CALIF.
NEW ORLEANS, LA.
NEW YORK CITY, N.Y.
PHILADELPHIA, PA.
PITTSBURGH, PA.
SAN FRANCISCO, CALIF.
SEATTLE, WASH.
ST. LOUIS, MO.
ST. PAUL, MINN.
TULSA, OKLA.
TORONTO, ONT., CAN.
VANCOUVER, B. C., CAN.

For more data on advertised products, use Readers' Service Cards, last page.

HYDRIL BALL PLUG Type "K" VALVES

COMPRESSIBLE PORT SEAL
provides
POSITIVE SHUTOFF



Hydril Ball Plug Valves achieve a positive seal against pressure from either direction because the fully enclosed packing ring is *mechanically pressed* tightly against the spherical plug and its seat after the valve is closed.

No other valve has this *controlled* port sealing feature.

SEEP-PROOF, BUBBLE PROOF. The fully confined packing ring is tightly squeezed against plug and seat so that it flows into surface imperfections, around sediment . . . even closes scratches that may occur on the sealing surfaces.

PORT SEAL RETRACTS for easy operation. The mechanical pressure against the port seal is released before plug rotation commences to eliminate seal ring wear and assure easy operation.

•

Write for catalog describing Hydril Ball Plug Valves in full detail.

Another dependable Hydril pressure-control product

HYDRIL COMPANY

714 W. Olympic Boulevard, Los Angeles 15, California

Sales offices: Bakersfield, Los Angeles, Ventura, California; Harvey, New Iberia, Louisiana; Oklahoma City, Tulsa, Oklahoma; Rochester, Pennsylvania; Corpus Christi, Dallas, Houston, Midland, Odessa, Texas; Casper, Wyoming; Farmington, New Mexico; New York, New York; Calgary, Edmonton, Canada.

For more data on advertised products, use Readers' Service Cards, last page.

"Ferulok"® flareless fittings in steel and stainless steel for fast, easy installations on either thin-wall or heavy-wall tubing from ⅛" to 2" O.D.

Only from Parker

so complete a range of tube fittings for process and instrument lines

Select the proper tube fittings for any of your process or instrumentation lines from hundreds of different sizes, shapes and alloys in the Parker fittings line.

Parker "Intru-lok" fittings for fast, easy assembly of low- and medium-pressure lines in metal or plastic tubing. Fittings come ready to use without disassembly.

"Triple-lok" flare-type fittings make up leak proof on high pressure, high temperature lines. They are ASME-approved, ideal where safety is vital.

Leak-free, vibration-proof "Ferulok"® flareless, bite-type fittings hold pressure-tight on thin-wall or heavy-wall steel or stainless tubing. For semi-permanent joints on critical applications, use "Braze-lok" fittings on O.D. tubing. And use "Weld-lok" for highest temperatures and pressures.

Call your Parker fittings distributor for prompt delivery of Parker fittings from local stocks. He can also offer expert advice on any process or instrument tubing installation.

"Intru-lok" brass or aluminum flareless fittings for fast, easy installations on either plastic or metal tubing. (⅛" to 1" O.D.)

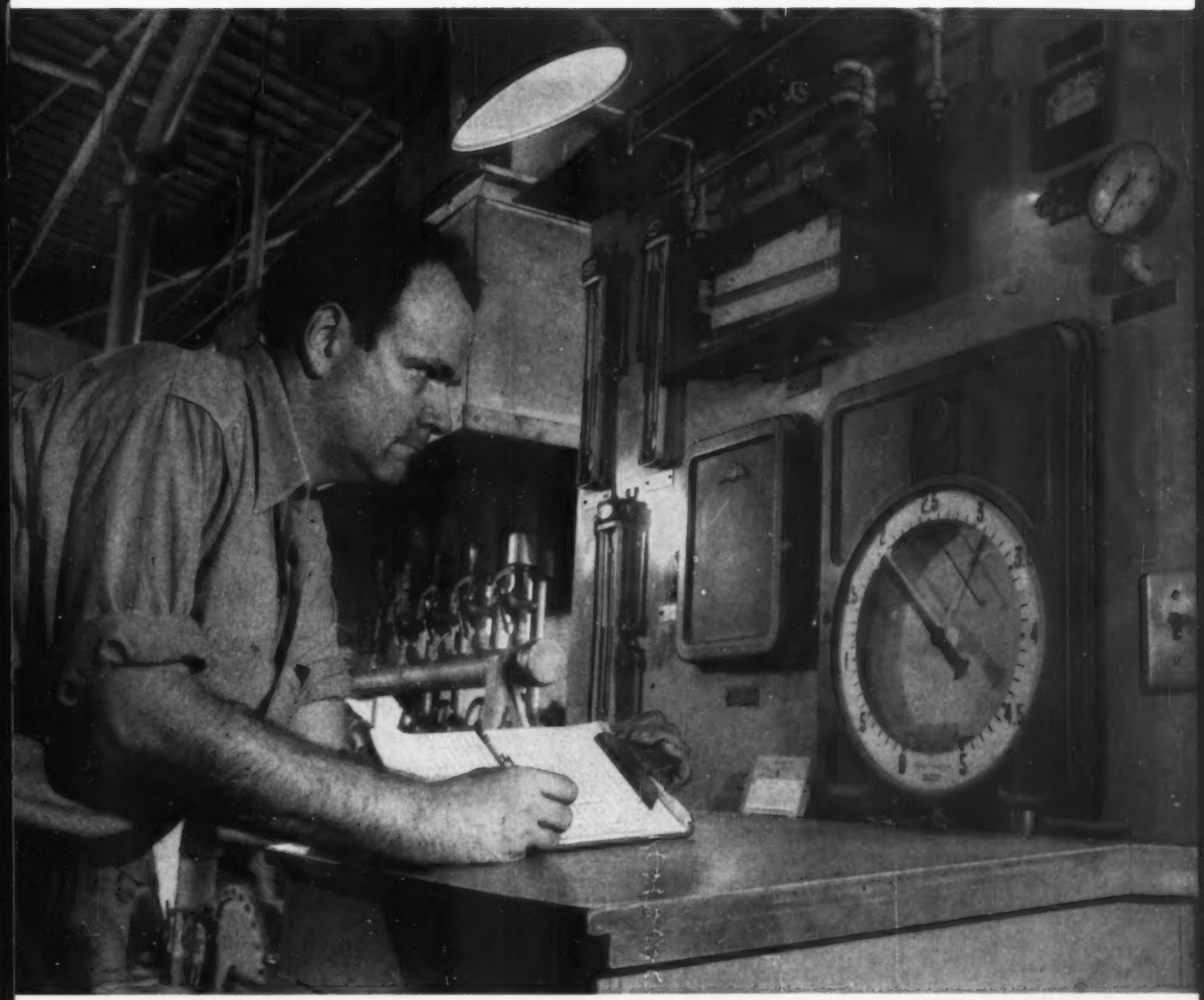
"Weld-lok" in steel and stainless steel for highest temperatures. "Braze-lok" in stainless steel, monel and Naval brass, silver-brazed for strength and reliability. (⅛" to 2" O.D.)

"Triple-lok" 37° flare-type fittings in brass, aluminum, stainless, and cadmium-plated steel for safe, trouble-free service. (⅛" to 2" O.D.)

Parker FITTINGS AND HOSE DIVISION

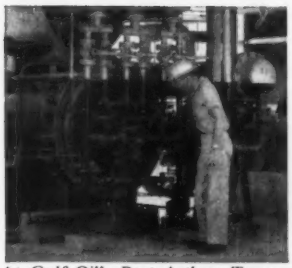
17325 Euclid Avenue • Cleveland 12, Ohio

A DIVISION OF PARKER-HANNIFIN CORPORATION



For tested generator performance . . .

Come to Kemp



At Gulf Oil's Port Arthur, Texas refinery, purging inerts are supplied by Kemp Generator and Kemp Dryer working as a team. The units produce 30,000 SCFH for a bountiful and easily controlled supply at low cost.

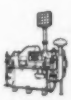
Tested . . . and proved! Factory tested with rigid component checks, field tested by Kemp engineers at installation, and time tested by years of actual use. Proved that Kemp Inert Gas Generators are built to last, built to produce, built to be accurate.

At the heart of every Kemp Generator is the Kemp Industrial Carburetor, uncomplicated in concept, yet outstanding in performance. It provides sensitive and accurate control of inert analysis. A quick setting of the calibrated dial insures delivery of an unvarying mixture, regardless of line demands.

And Kemp design—rugged, simple, and sturdy—means that maintenance and attendance requirements are kept to a bare minimum. Kemp Inert Gas Generators stand up under the toughest conditions, yet produce with complete dependability.

To get detailed information and ideas, give your Kemp Representative a call. Or write us direct for Bulletin I-10. THE C. M. KEMP MFG. Co., 405 East Oliver St., Baltimore 2, Maryland.

Convection Dryers



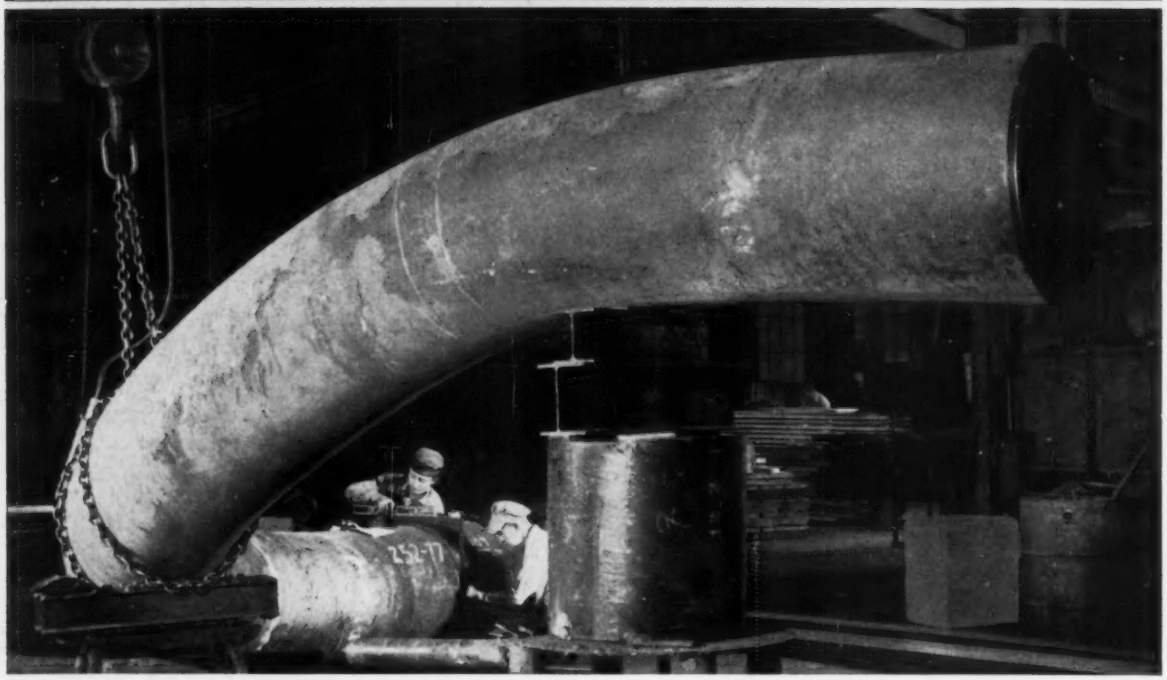
Atmos Generators

KEMP OF BALTIMORE

Nitrogen Generators

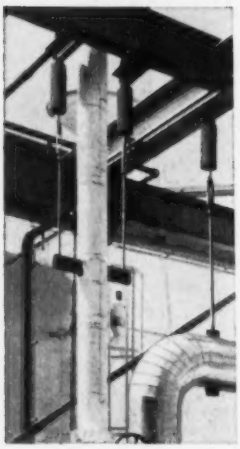
Oriad Dryers

BLAW-KNOX has what it takes—to provide these products and services



Large chrome moly pipe being readied for shipment to new generating station. Making a right angle bend followed by a 24 degree, 18 foot bend in this heavy 27½ inch chrome moly pipe required all the skill and modern facilities of the Blaw-Knox power piping shop. Before shipment, piping is heat-treated and ultrasonically tested with a radar-type device for detection of any defects.

A new Blaw-Knox "6 x 6" Flexibility Matrix Method of computing stresses in power piping systems is now available to consulting engineers, companies, and individuals responsible for the design of power piping systems. By the use of an electronic computer this method cuts calculating time from months to a day; assures full accuracy to six significant figures; and has no limitations on the complexity of the system. Write for further information about our new "6 x 6" Flexibility Matrix Method.



Two-way control over movement of piping is provided by Blaw-Knox functional spring hangers with the patented internal swivel action—shown in this modern outdoor generating station. Our experienced engineers are available to both design and make recommendations for your hanger requirements. To get full information, write for Catalog No. 54.

Each year serious fire strikes one out of every seven manufacturing firms in this country. Be safe. Let a Blaw-Knox fire-protection engineer study your needs—and explain how you can pay for the system on our lease or deferred payment plan. To get more information send for Bulletin No. 2426—"Fire Can Destroy Your Business."

BLAW-KNOX

BLAW-KNOX COMPANY

Power Piping and Sprinkler Division

829 Beaver Avenue • Pittsburgh 33, Pennsylvania

Complete facilities for prefabrication and erection of piping systems for all pressures and temperatures ... complete line of standard and custom-engineered pipe hangers, supports and vibration eliminators ... complete line of automatic sprinkler systems for standard and special hazards

YOU never saw a metering pump

like this!

NEW streamlined safety shield. NEW crank-type design. NEW improved accuracy. NEW parts interchangeability. NEW operational efficiency. NEW maintenance ease . . .

all at a new lower price!

Meet Hills-McCanna Masterline . . . four metering pump models developed to bring increased economy and accuracy to metering and proportioning! Tested and proved capable of registering new highs in performance and dependability. Hills-McCanna Masterline pumps handle payloads from a fraction of a gallon to 1030 gph per feed . . . and are designed all new *inside* and *out* to do it better than ever. For new maintenance ease and the best pump investment, investigate Masterline pumps *now* for your chemical proportioning, water treatment, petroleum addition and other similar needs!

Write for informative new booklet! Just published, this new booklet gives all the details on Hills-McCanna Masterline Metering Pumps . . . pinpoints the features and elements that make Masterline pumps tops—for now and the future. Ask for Bulletin #900 "Look What's New in Metering Pumps." *Hills-McCanna Co., 4614 W. Touhy Avenue, Chicago 46, Illinois.*

hills-mccanna company

THE PEOPLE WHO KNOW AND CONTROL FLOW

For more data on advertised products, use Readers' Service Cards, last page.

How modern refineries maintain maximum temperatures in tracer lines . . . without interruption

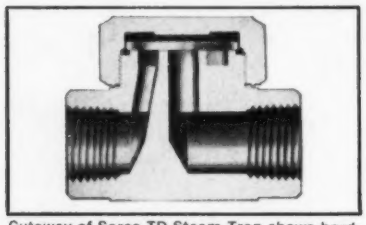
Production-Planned steam trapping insures continuous operation of process lines at design temperatures

By John W. Ritter, Test Engineer
SARCO Company, Inc.

The maintaining of design temperatures in tracer lines may appear, at first glance, to be an extremely difficult problem. Temperature, of course, must be maintained at a uniform level; but unless air and air-steam mixtures are removed from the line, design temperatures are difficult to maintain. Further, because of extremely long lines, water hammer is inherent in tracer lines.

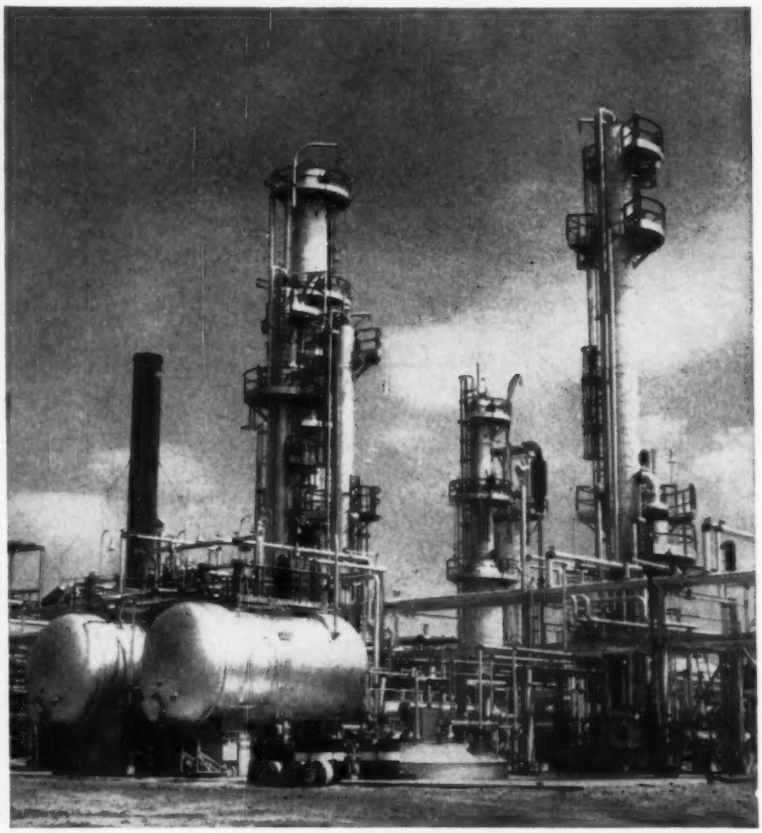
However, if a trap is selected which operates over a full range of pressures, ambient temperatures, and loads, it will drain the tracer line automatically. For many leading refineries the new Sarco TD-50 Thermo-Dynamic Steam Trap has proved a sound solution to this problem. Dozens of refineries from New Jersey to California, from Montana to Louisiana, originally started using Sarco TD's on a test basis. After experiencing the thoroughness of their day-to-day trapping operation, these refineries standardized on TD's.

The TD-50 has excellent resistance to water hammer, and it drains air and condensate as fast as they reach the trap. This trap helps to maintain constant temperatures, and operates perfectly on variations in pressures and temperatures.



Cutaway of Sarco TD Steam Trap shows hardened stainless steel disc, which is the only moving part in the unit.

Lightness of weight and compactness of design are advantages of the TD which make it particularly valuable for use in draining tracer line tubing. The TD is easily installed and, because of its unique thermo-dynamic principle of operation, it can be installed vertically (with a free discharge downwards) in self-draining, antifreeze applications.



Some 250 Sarco Thermo-Dynamic Steam Traps are installed on the tracer lines of this new catalytic hydrodesulphurization unit at Socony Mobil Oil Company's Paulsboro, N. J., refinery.

SARCO TD-50 Steam Traps provide ideal solution to tracer line drainage at Paulsboro, N. J.

The 250 Sarco TD's used to drain steam tracer lines at Socony Mobil's Paulsboro refinery were selected for reliability. They can never "fail closed," never block heat transfer. TD's remove condensate and air as fast as they collect.

Since tracer lines are usually in exposed installations, the wide pressure range of TD's is important here. These TD's operate perfectly through a variety of weather conditions, temperature changes and load variations.

TD's have just 3 simple parts, all of stainless steel. They have high resistance to water hammer and to corrosion. They are easy to install and 90% of the TD's at Socony Mobil are mounted vertically for non-freeze operation. Maintenance is extremely low, often negative.

Write for literature today. Remember that Sarco can give you impartial advice on steam trapping because . . . 5928-B

SARCO
COMPANY, INC.
635 Madison Ave., New York 22, N. Y.

Only Sarco makes all 5 types:
Thermostatic • Liquid Expansion • Float Thermostatic
Thermo-Dynamic • Bucket

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES

TO MARK PROGRESS

LADISH

Controlled Quality

LIGHT WEIGHT WELDING FITTINGS

developed for economical, dependable low pressure piping systems

LOWER COST

Substantial savings realized in purchase price of fittings and pipe.

REDUCED WEIGHT

Important weight reductions achieved by reducing wall thickness to correspond with service requirements.

GREATER FLOW

Larger inside diameter provides increased flow capacity.

EASE OF INSTALLATION

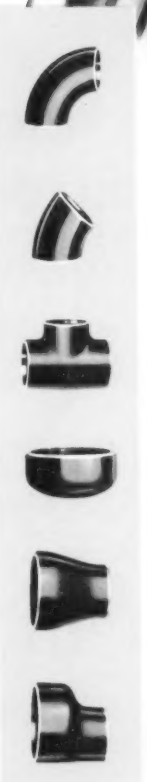
Reduced weight facilitates handling . . . speeds installation.

AVAILABILITY

Stocked in sizes 4" through 24". Wall thicknesses range from .188" to .250".

CONFORMITY TO SPECIFICATIONS

These fittings meet all requirements of ASA Code for Pressure Piping B31.1 —1955 and B31.1.8—1955, ASTM A234 and ASA B16.9.



Lower purchase cost . . . reduction in weight . . . economy and ease in installation . . . increase in flow capacity—these are multiple advantages gained in using Ladish Light Weight Seamless Welding Fittings.

These Light Weight Fittings have been developed and produced under rigid metallurgical and manufacturing standards as part of a continuing program to meet the specific needs of industry for economical, functionally designed fittings.

Specification sheets on Light Weight Welding Fittings and Flanges available on request.

TO MARK PROGRESS

LADISH CO.

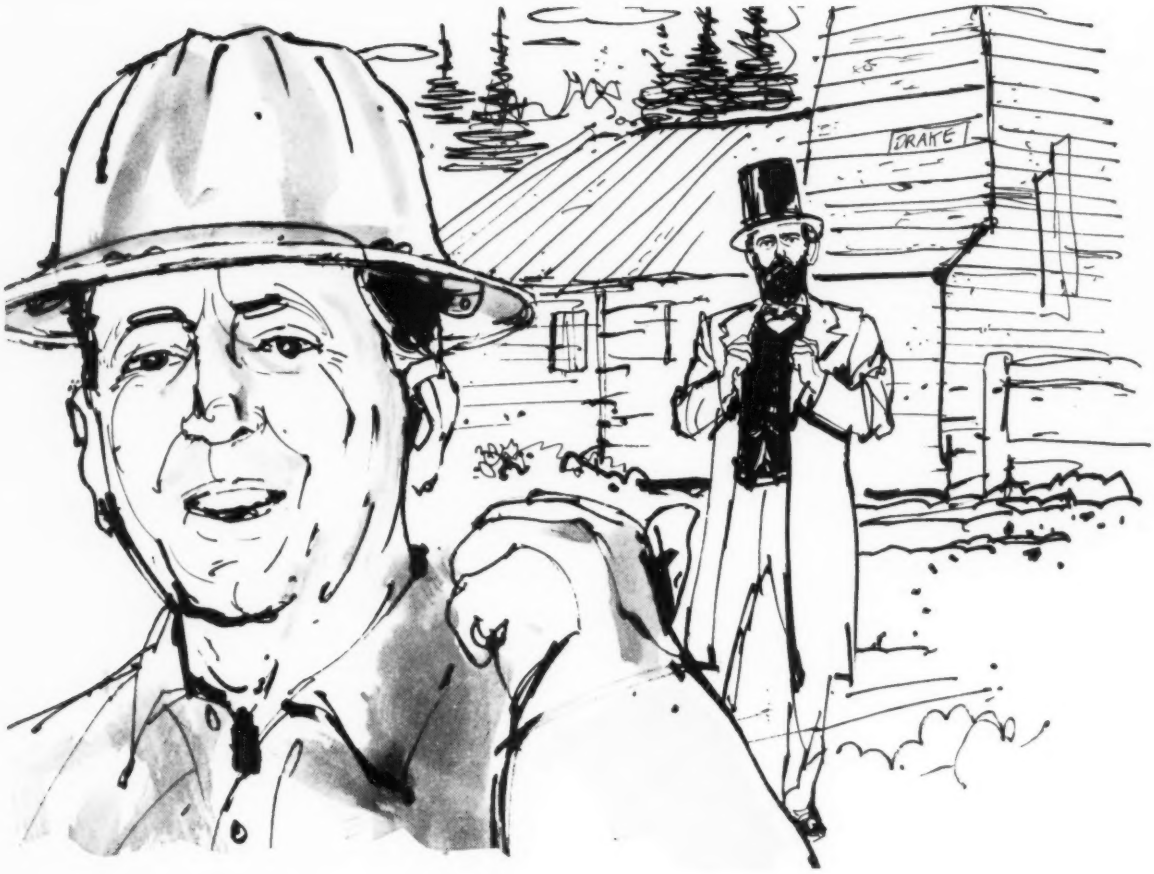
CUDAHY (Milwaukee Suburb) WISCONSIN

SALES OFFICES: Amarillo • Atlanta • Baton Rouge • Buffalo • Calgary Chicago • Cincinnati • Cleveland • Denver • Havana • Houston • Los Angeles Mexico City • Montreal • New York • Odessa • Philadelphia • Pittsburgh St. Louis • St. Paul • San Diego • San Francisco • Seattle • Toronto • Tulsa

SAW BLADES • PIPE FITTINGS • DROP FORGINGS • RINGS • VALVES

LADISH...THE FITTINGS LINE THAT OFFERS COMPLETE SERVICE IN TYPES, SIZES AND MATERIAL SPECIFICATIONS

WELDING FITTINGS	ASA & MSS FLANGES	SCREWED & SOCKET FITTINGS & UNIONS	LONG NECKS	LARGE DIAMETER & T.E.M.A. FLANGES



Meet the man who started us in business just one hundred years ago

He's Edwin L. Drake—who drilled the world's first commercial oil well in Titusville, Penn.—August 27, 1859

Your business and mine started when Edwin L. Drake decided to drill rather than dig for oil in Titusville. Some men laughed at Drake, some scoffed and others ignored him completely.

But no man questioned Drake's right to try out a new idea or his freedom to work as he chose. In this unique climate of freedom, America's oil industry was born.

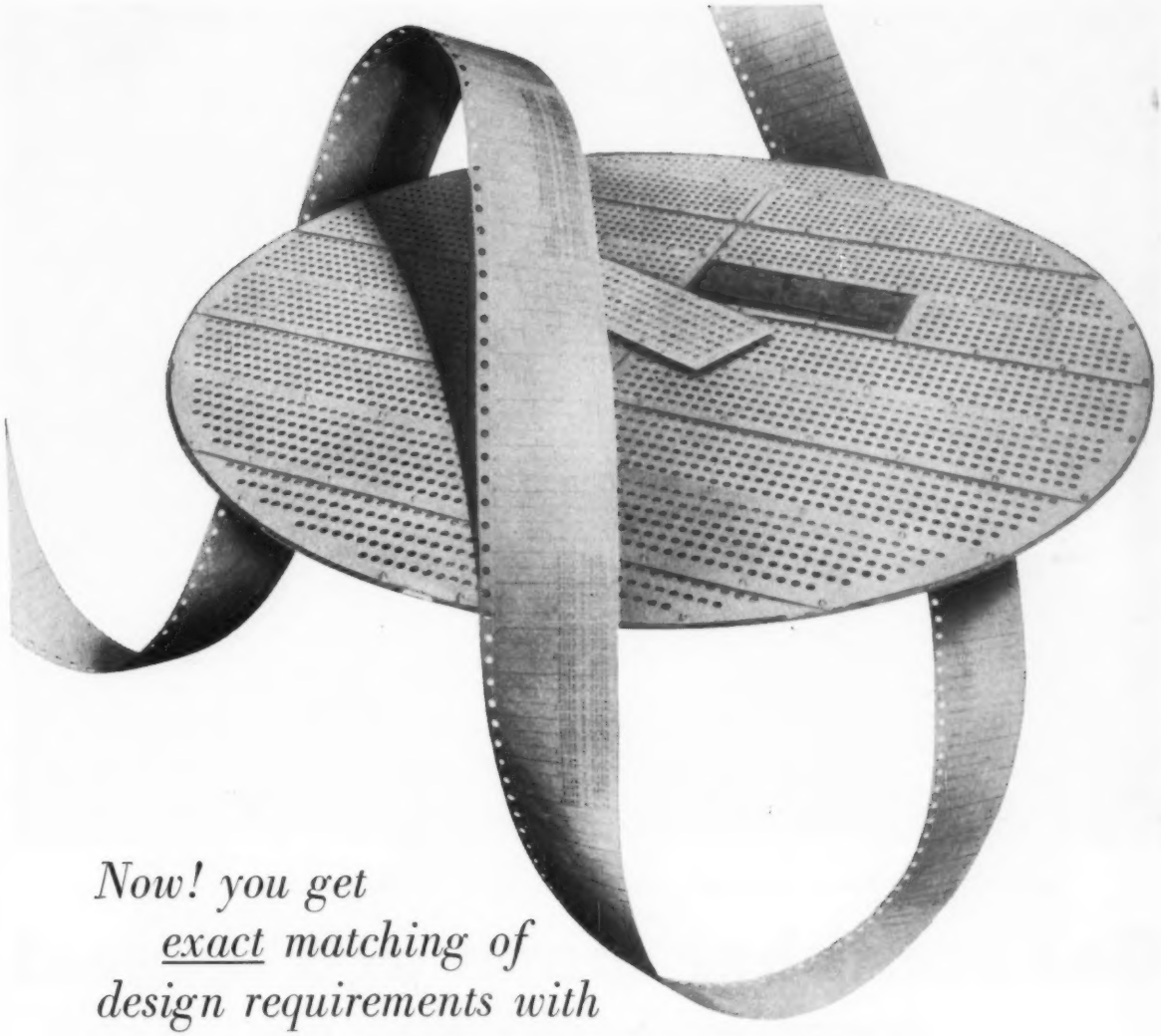
Today, one hundred years later, preservation of the freedom to try new ideas and develop new products to win the favor of our customers remains our greatest challenge. Responsible enterprise is still the very foundation of the oil business...as it has been throughout one hundred years of service to the American people.

Oil's one hundredth anniversary offers every oilman the opportunity of a century to tell his neighbors how his business serves them. This is a proud story and we can be proud to tell it during this Centennial year.

OIL'S FIRST CENTURY
-BORN IN FREEDOM
WORKING FOR PROGRESS

COMMITTEE ON PUBLIC AFFAIRS OF THE AMERICAN PETROLEUM INSTITUTE • 50 WEST 50th STREET • NEW YORK 20, NEW YORK

For more data on advertised products, use Readers' Service Cards, last page.



Now! you get
exact matching of
design requirements with

HENDRICK COMPUTER-RATED COLUMN INTERNALS!

When your design figures are fed to our electronic computer, they're quickly turned into column internal specifications that provide maximum operating efficiency. That's why Hendrick Perforated Trays can offer you these important advantages:

- Smaller column diameter for a given process capacity.
- Lower initial cost.
- Higher vapor thru-put.
- Less entrainment
- Simpler tray construction.
- Easy maintenance.
- A wide range of stable operation.

Available in all types of commercially rolled metals. Stainless steel or other corrosion-resistant metals are recommended for corrosive services. As a result, you can now cut replacement costs and production losses caused by downtime, change-overs or cleaning – just by working with Hendrick engineers.

HENDRICK
MANUFACTURING COMPANY

Perforated Metal • Perforated Metal Screens • Wedge Slot and Hendrick Wedge Wire Screens • Architectural Grilles • Mitco Open Steel Flooring • Shur-Site Treads • Armorgrids • Hendrick Hydro-Dehazer • Distillation Column Internals

Hendrick is licensed to manufacture ESSO "Jet-Trays," SOCONY "Uniflux," SHELL "Turbo-Grid" and STONE and WEBSTER "Ripple" Trays. Hendrick is also equipped to supply all types of trays to specifications.

Clip the coupon for full information.

Hendrick Manufacturing Company
36 Dundaff Street, Carbondale, Penn.

Gentlemen:

☐ Please send FREE Bulletin C1-2
☐ Have representative call

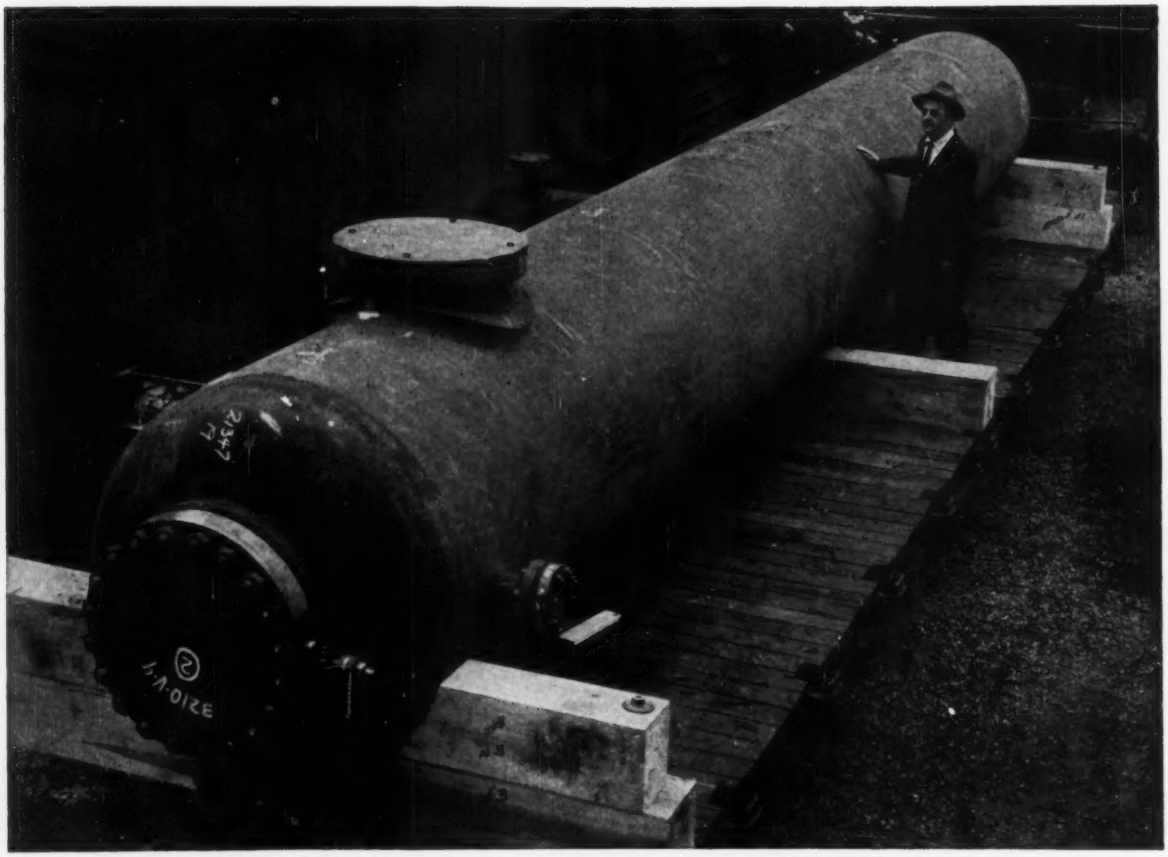
Title_____ Name_____

Company_____

Address_____

City_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.



NEWPORT NEWS BUILT two 39′-7″ horizontal gas scrubbers, such as this, for J. F. Pritchard & Co. They were made of ASTM-A212 Grade B fire box steel, with structural mesh steel interiors.

Gas scrubber made of 2⅞″ steel

Newport News builds almost any type of pressure vessel and other heavy process equipment

Here is one of two horizontal gas scrubbers recently built for an operating pressure of 1800 psi at 300°F.

Newport News made both vessels from fire box steel, 2⅞ inches in thickness. We formed and automatically welded this steel into sections having a diameter of only 4 feet.

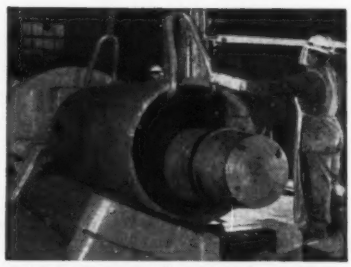
Rolling thick steel to this small diameter...no easy accomplishment, as you probably know . . . demonstrates the sort of jobs Newport News takes in stride.

Almost any type of heavy processing equipment is readily constructed by Newport News in a 225 acre plant comprising huge, fully equipped fabricating and machine shops, foundries, forge and die shops, heat treating and allied equipment as well as complete test facilities.

Newport News shop erection of fabricated units helps to speed assembly at your plant site.

Get a bid from Newport News on your present or future projects. Get the benefit of specialized production techniques. Look over the many ways in which Newport News can help you . . . write for "Facilities and Products", a very interesting booklet. It's yours for the asking.

ENGINEERS Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.



ROLLING 2⅞″ STEEL for gas scrubbers. The steel, in a hot condition, was formed on the heavy bending equipment shown here. It will cold roll mild steel up to 3 inches thick, and will hot roll any grade of steel up to a thickness of 5 inches.

Newport News Shipbuilding and Dry Dock Company
Newport News, Virginia

All this and MORE OIL

IN EVERY DROP OF

See on parade—exploration, drilling, production, pipeline, refining equipment and services which make the oil available for use in hundreds of items some of which are shown.

International Petroleum Exposition

MAY 14-23 . . .

1959

TULSA, U.S.A.

For Exhibit Space Write
IPE, Box 5205 Donaldson Sta.
Tulsa, Oklahoma

For Accommodations Write
IPE Housing Bureau
Oil Capitol Bldg.
Tulsa, Oklahoma

Commemorating

THE CENTENNIAL OF THE PETROLEUM INDUSTRY

Dates of the IPE set in conjunction with World Petroleum Congress to be held in New York a week after the Tulsa Show

For more data on advertised products, use Readers' Service Cards, last page.

BETTER AIR CONDITIONING FOR EVERYBODY EVERYWHERE

Carrier

Carrier multi-level refrigeration

saves $60,000 in installation costs!

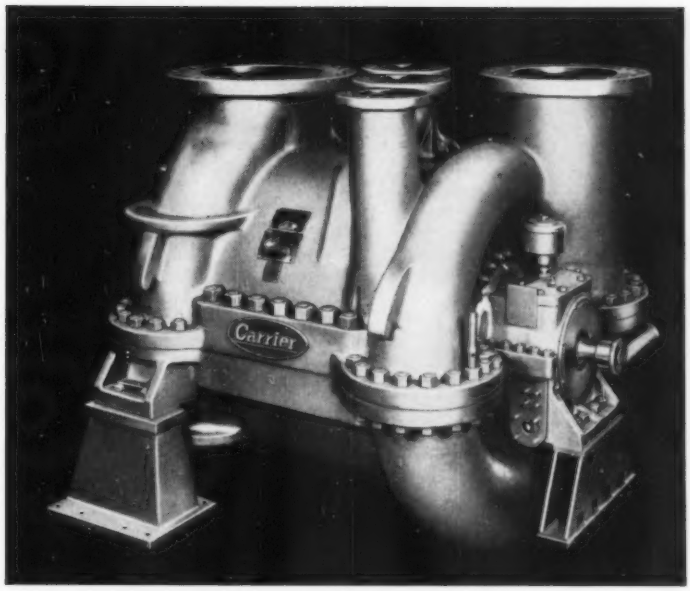
Problem: To provide propane refrigeration at four temperature levels—minus 35° F, minus 3° F, plus 28° F and plus 64° F—in a southwestern natural gas extraction plant.

Conventional solutions: (a) Install four separate compressors. (b) Install two compressors. (c) Install one compressor with no side loads.

Carrier solution: Install a single Carrier Centrifugal Compressor with side loading.

Installation savings: Savings on the installed cost of the single Carrier Centrifugal, exclusive of drivers and their installation costs—in comparison with the conventional solutions (a) $60,000. (b) $28,000. (c) No installation savings, but note big horsepower savings below.

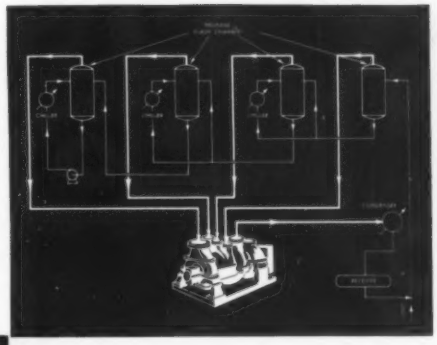
Horsepower savings: Power savings resulting from use of the Carrier Centrifugal—in comparison with (a) none. (b) 1230 hp. (c) 3400 hp.

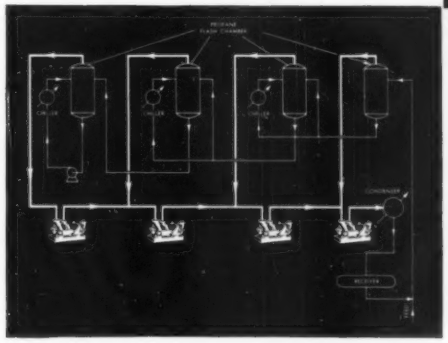


Multi-stage, heavy-duty Carrier Centrifugal Compressors with broad application flexibility are available in capacities up to thousands of tons, depending on your requirements.

Now you can effect substantial savings in horsepower and installation costs by using a single Carrier Centrifugal Compressor for refrigeration in many processing applications. These multi-stage, heavy-duty compressors provide definite installation and operating advantages. For example. Side loading for split load requirements. Extreme flexibility of arrangement with coolers and condensers. High lift or wide temperature range in two to nine stages. Variable inlet guide vanes for capacity control. Suitable for all types of drives. Versatile use with any high-pressure refrigerant.

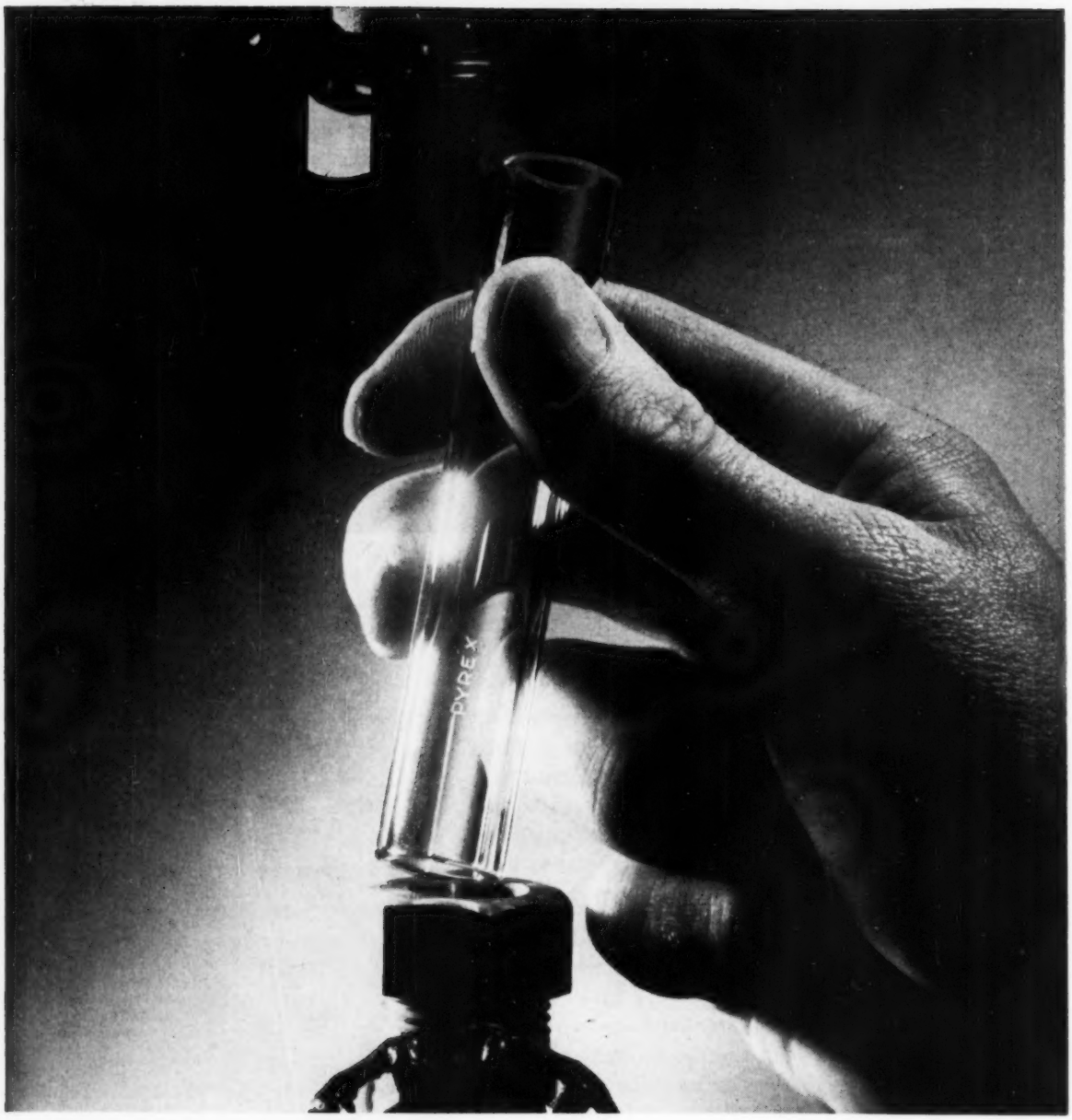
These big-tonnage compressors are built to the same high-quality standards that have earned Carrier the reputation for round-the-clock dependability in thousands of installations. Carrier specialists draw on experience unmatched in the field. For specific recommendations for your requirements, call the Carrier office nearest you. Or write Carrier Corporation, Syracuse 1, New York.





In a natural gas extraction plant in the Southwest, one Carrier Centrifugal Compressor handling four gas streams with side loading accomplishes the same results as four separate compressors. Compared with the conventional installation, savings on installed cost of the Carrier unit totaled about $60,000, exclusive of driver installation costs.

For more data on advertised products, use Readers' Service Cards, last page.



A gauge glass installed...and two more on the shelf

Make short work of gauge glass replacement—when the replacement is as near as your stockroom shelves. You'll cut down time.

Take *three* gauge glasses the next time you order from your distributor. That gives you *one* for the gauge right away, a *second* for regular replacement, a *third* to cover special emergencies.

And here's another tip—don't rely on any old type gauge glass. Insist on regular replacement with PYREX®, CORNING®, or MACBETH® to avoid trouble.

These gauge glasses last longer—because they're harder to break! They stand up better to just about every clouding hazard. They easily resist high temperatures and high pressures.

One of these brands is just right for your gauge. Get some from your regular mill supply dealer. And remember—ask for *three* for each gauge!

(Corning makes sight glasses, too—from tough PYREX brand glass. Use them whenever you must see what's going on inside your processing equipment. Your distributor has them.)

Corning means research in Glass **CORNING GLASS WORKS, Corning, N. Y.**

STOP! And Consider These Authoritative Books

ADVANCES IN PETROLEUM CHEMISTRY AND REFINING (VOL. I)

Edited by Kenneth A. Kobe and John J. McKetta

Presents recent advances in the petroleum and petrochemicals industry. Subject matter was prepared and written by outstanding industry authorities.

CONTENTS (Condensed). Group I. Economics and Future Trends: Petroleum Operations In The U. S., by Richard J. Gonzalez; Present and Future Sources and Compositions, by Harold Gershinowitz; Fuel Trends, by Harold A. Beatty and Wheeler G. Lovell. Group II. Unit Operations and Designs: Separation and Purification By Crystallization, by Robert A. Findlay and John A. Weedman; Superfractionization, Azeotropic and Extractive Distillation, by S. B. Zdonik; New Fractionating-Tray Designs, by Frank J. Lockhart and C. W. Leggett. Group III. Refining Processes: Alkylation of Paraffins, by John O. Iverson and Louis Schmerling; Catalytic Reforming, by Vladimir Haensel and C. V. Berger; Solvent Refining, by Alfred W. Francis and William H. King. Group IV. Petrochemicals: The Oxo Processes, by Alexis Voorhies, Jr., John J. Owen and John F. Johnson; Solid Polymers From Surface Catalysts, by Herbert N. Friedlander and William Resnick. Group V. Mechanical Equipment: Power Plants of the Future, by C. G. A. Rosen.

1958, 656 pages, 131 illus., 86 tables.....Price $13.50

PETROLEUM REFINING WITH CHEMICALS

By Vladimir A. Kalichevsky and Kenneth A. Kobe

Provides a comprehensive treatise explaining the various problems encountered in refining and finishing petroleum products. Detailed explanations are given on petroleum refining with chemicals and solvents, use of additives for improving quality of petroleum products, modern testing methods and their interpretations, concept of color (as applied to color of petroleum oils, etc.), as well as other theories such as lubrication, viscosity, surface tension, vapor pressure, boiling point, fire and flash point, octane number, etc. The extensive use of thousands of patents on subjects covered and the wealth of reference to the literature are of particular value.

1956, 700 pages, illustrated.....Price $17.50

PETROLEUM DICTIONARY

By Hollis P. Porter

A valuable book for office, field and plant. Beginners in the oil industry (young technicians, secretarial and clerical) and old-hands in the oil business will find the Petroleum Dictionary to be of real interest and value to them. It is convenient to use, easy-to-read and understand. No other work of a similar nature compares with its thoroughness and dependability. It will be a valuable adjunct to the libraries of executives, engineers, students of the oil industry —in fact anyone who is in anyway connected with or interested in the petroleum industry.

1948, 326 pages.....Price $6.00

VOLUMETRIC AND PHASE BEHAVIOR OF HYDROCARBONS

By Bruce H. Sage and William N. Lacey

Book considers fundamental principles and facts relating to hydrocarbon behavior not involving chemical reactions or changes in molecular species present. Subject matter is developed in a logical manner, without assuming the reader has made intensive studies of physical chemistry.

CONTENTS (Condensed). Introduction: Hydrocarbon Series, General Definitions, Equilibrium. Mathematical Concepts: Analytical and Graphical Methods, Graphical Differentiation. Behavior of Pure Substances: Phase and General Behavior, Gases, Liquids, Critical Region. Two-Component Systems: Single- and Two-Phase Regions, Critical Behavior of Mixtures, Effect of Pressure, Temperature and Composition on Volume, Constant Boiling Mixtures, Partly Miscible Liquids, Condensed Systems, Two-Phase and Critical Regions, Systems of Variable Composition, Effect of Composition on Dew- and Bubble-Point Pressure and on Volume of Ternary Systems, Condensed and Liquid-Gas Systems. Multi-Component Systems: Composition, Two-Phase Region for Systems of Constant Composition, Materials of Restricted Boiling Range, Gas-Cap Materials, Mixture of Crude Oil and Natural Gas, Composition of Coexisting Phases, Systems of Variable Weight. Phase Rule. Partial Quantities: Ternary and Multi-Component Systems, Apparent Partial Quantities. Ideal Solutions: Fugacity, Raoult's Law, Deviations From Ideal Solutions and Raoult's Law, Phase Behavior at Higher Pressures.

1949, 299 pages, illustrated.....Price $5.00

THE CHEMISTRY OF PETROCHEMICAL REACTIONS

By Lewis F. Hatch

This completely indexed volume provides a thorough, exhaustive treatise of reactions and processing of petrochemicals. It is an immediate reference for anyone engaged in the chemical or refining industry. In addition to technical data, valuable commentaries on end use and market of many significant chemicals are presented in a manner that makes this book a practical working manual.

CONTENTS (Condensed). Petroleum as a Raw Material for the Chemical Industry, Non-Hydrocarbon Constituents of Petroleum (Sulfur, Nitrogen and Oxygen Compounds). Oxydation of Hydrocarbons. Chlorination, Nitration and Sulfonation of Paraffin and Aromatic Hydrocarbons. Production and Reaction of Olefins. Alcohols from Olefins. Halogenation, Oxidation, Alkylation and Polymerization of Olefins. The Oxo Reaction-Primary Alcohols from Olefins. The Production and Reactions of Butadiene. Preparation and Properties of Acetylene, Air and Methane.

1955, 192 pages, illustrated.....Price $4.50

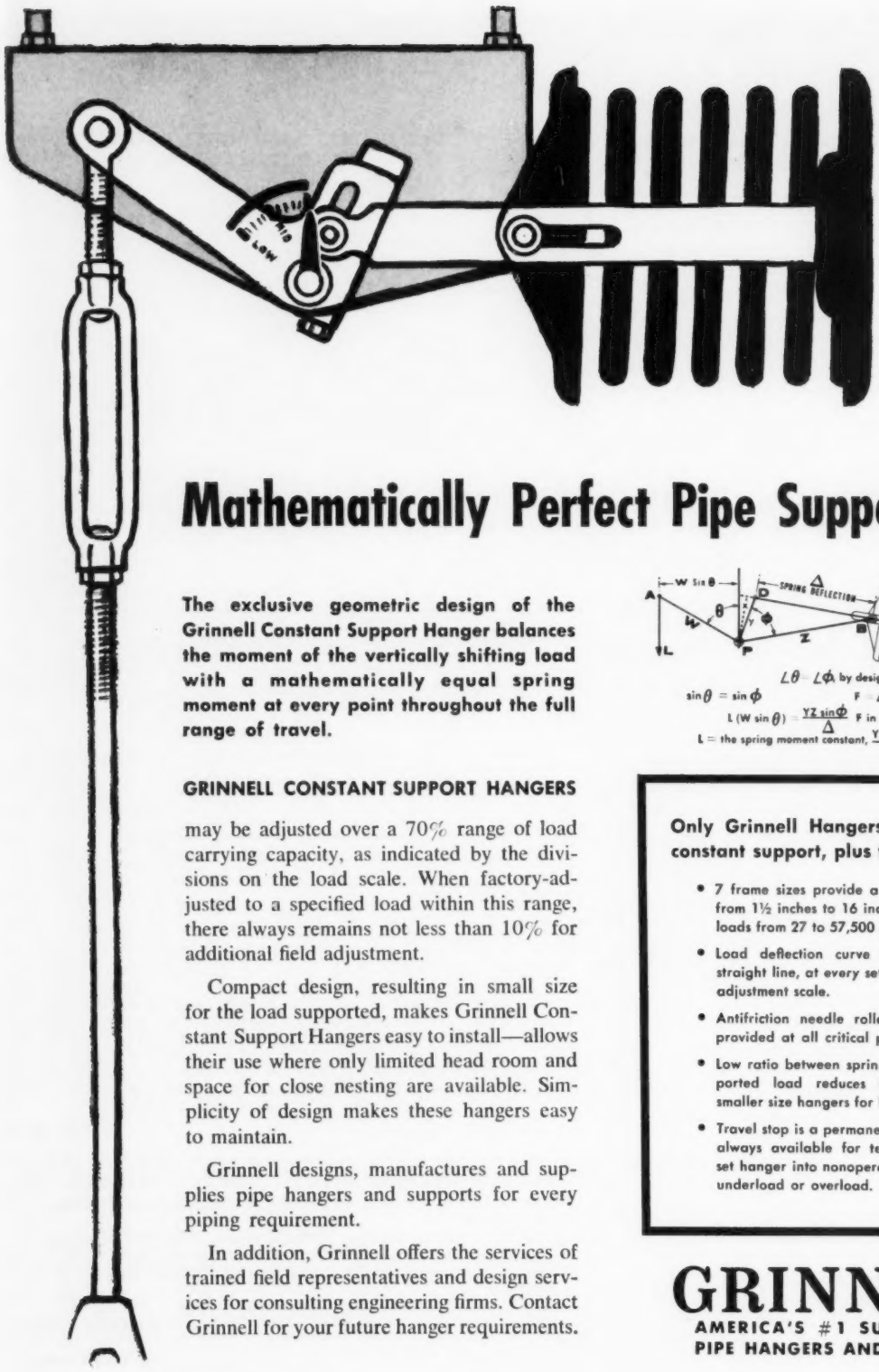
The GULF PUBLISHING COMPANY, P. O. Box 2608, Houston 1, Texas

Send Me: ____Copies of Vol. I, Advances In Petroleum Chemistry and Refining, Price $13.50 a copy.
____Copies of Petroleum Refining With Chemicals, Price $17.50 a copy.
____Copies of The Chemistry Of Petrochemical Reactions, Price $4.50 a copy.
____Copies of Volumetric & Phase Behavior of Hydrocarbons, Price $5.00 a copy.
____Copies of Petroleum Dictionary, Price $6.00 a copy.

☐ My Check Enclosed I Save Postage ☐ Bill Me ☐ Bill My Company
☐ 10-Day Free Examination ☐ Send Free Book Catalog

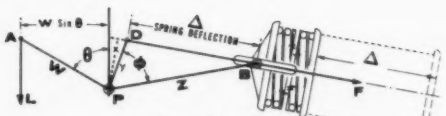
Name_____ Position_____
Company_____
Address ☐ Home ☐ Office _____
City_____ Zone____ State_____
Pro-Forma Invoice Outside the U. S.

For more data on advertised products, use Readers' Service Cards, last page.



Mathematically Perfect Pipe Support!

The exclusive geometric design of the Grinnell Constant Support Hanger balances the moment of the vertically shifting load with a mathematically equal spring moment at every point throughout the full range of travel.



$L\theta = L\phi$, by design

$\sin\theta = \sin\phi$ $\quad F = \Delta \times$ spring constant

$L(W \sin\theta) = \frac{YZ \sin\phi}{\Delta} F$ in all positions

L = the spring moment constant, $\frac{YZ \times \text{spring constant}}{W}$

GRINNELL CONSTANT SUPPORT HANGERS

may be adjusted over a 70% range of load carrying capacity, as indicated by the divisions on the load scale. When factory-adjusted to a specified load within this range, there always remains not less than 10% for additional field adjustment.

Compact design, resulting in small size for the load supported, makes Grinnell Constant Support Hangers easy to install—allows their use where only limited head room and space for close nesting are available. Simplicity of design makes these hangers easy to maintain.

Grinnell designs, manufactures and supplies pipe hangers and supports for every piping requirement.

In addition, Grinnell offers the services of trained field representatives and design services for consulting engineering firms. Contact Grinnell for your future hanger requirements.

Only Grinnell Hangers provide true constant support, plus these features:

- 7 frame sizes provide a range of travel from 1½ inches to 16 inches and support loads from 27 to 57,500 pounds.
- Load deflection curve is a horizontal straight line, at every setting on the load adjustment scale.
- Antifriction needle roller bearings are provided at all critical pivot points.
- Low ratio between spring force and supported load reduces friction, permits smaller size hangers for loads carried.
- Travel stop is a permanent attachment — always available for temporary use to set hanger into nonoperative position for underload or overload.

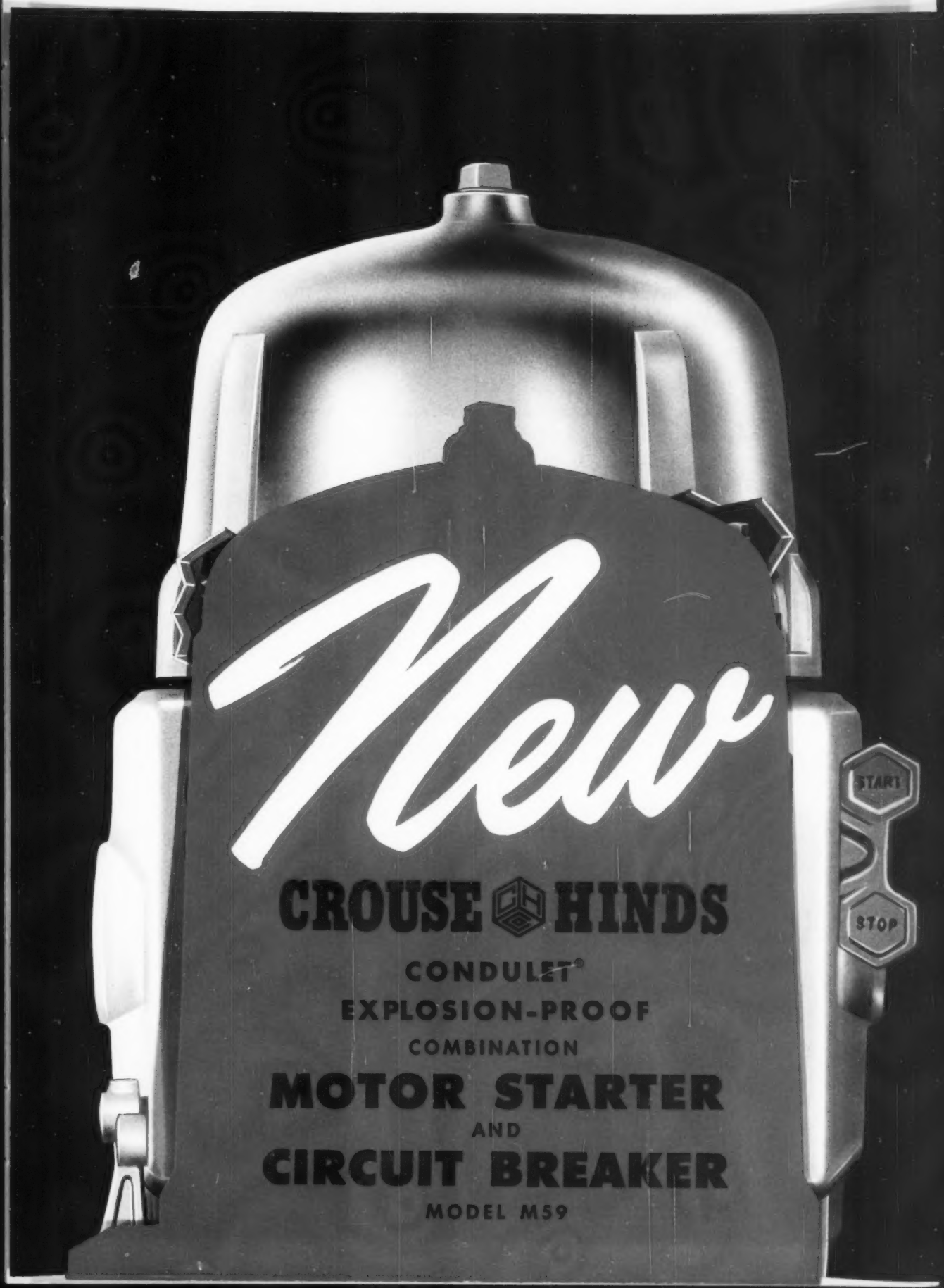
GRINNELL

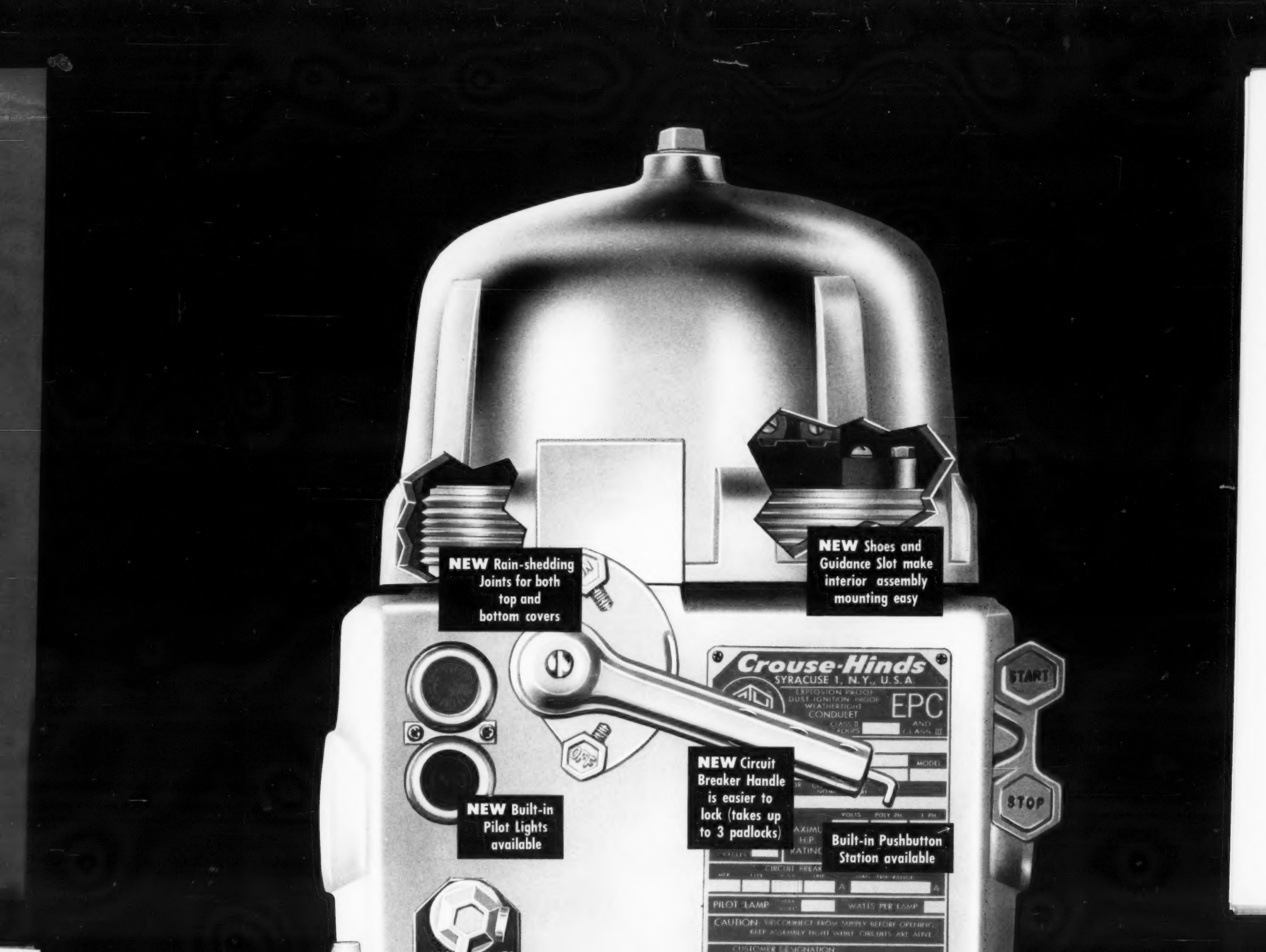
AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

For more data on advertised products, use Readers' Service Cards, last page.

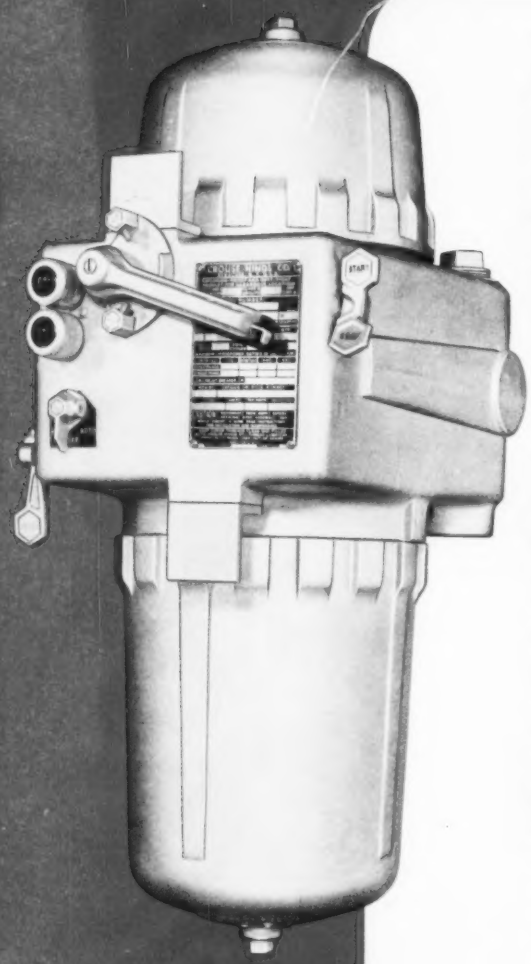

New
CROUSE HINDS
CONDULET
EXPLOSION-PROOF
COMBINATION
MOTOR STARTER
AND
CIRCUIT BREAKER
MODEL M59
START
STOP


NEW Rain-shedding Joints for both top and bottom covers
NEW Shoes and Guidance Slot make interior assembly mounting easy
NEW Built-in Pilot Lights available
NEW Circuit Breaker Handle is easier to lock (takes up to 3 padlocks)
Built-in Pushbutton Station available
Crouse-Hinds
SYRACUSE 1, N.Y., U.S.A.
EXPLOSION PROOF
DUST-IGNITION PROOF
WEATHERTIGHT
CONDULET
EPC
CLASS II GROUPS AND CLASS III
MODEL
VOLTS
POLY PH.
1 PH.
H.P. RATING
CIRCUIT BREAK
PILOT LAMP
WATTS PER LAMP
CAUTION
CUSTOMER DESIGNATION
START
STOP

HAND
AUTO
OFF
Built-in Selector Switch available
RESET
CAUTION- DISCONNECT FROM SUPPLY BEFORE OPENING. KEEP ASSEMBLY TIGHT WHILE CIRCUITS ARE ALIVE
CUSTOMER DESIGNATION
LOCATION
NUMBER
H.P.
NEW Center Section (and covers) are lightweight aluminum
NEW Increased Internal Wiring Room
OTHER FEATURES ON BACK →

New Crouse-Hinds M59 Explosion-Proof Motor Starter and Circuit Breaker

gives you important extras at no increase in price

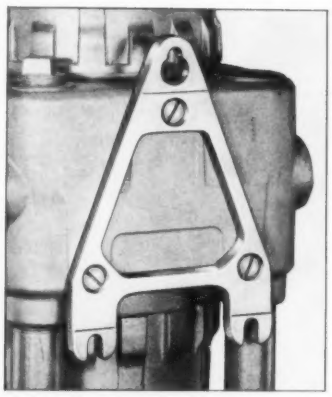


National Electrical Code: Class I, Groups C and D; Class II, Groups E, F, and G, Class III.

The M59 is now available in 7" (takes size 0 and 1 starters or combinations) and 9" (takes size 2 starters or combinations) sizes. 11" (for sizes 3 and 4 starters or combinations) size to follow.

Easy to Start Covers

New, notched covers loosen quickly with pinch bar or screwdriver.



Easy to Install

Three-hole bracket makes mounting fast and easy. Bracket is replaceable.

Other features include . . .

- Built-in breathers and drains available
- Seven taper-tapped conduit entrances
- Starter located below breaker for safe and easy maintenance
- Compact design permits greater number of motor controls in any given area

For more information, consult your Condulet Catalog, or see a Crouse-Hinds Distributor. Additional help is available from any of the Crouse-Hinds offices listed below.

CROUSE HINDS

MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK

Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

Crouse-Hinds Instrument Company, Inc., Silver Spring, Maryland

● CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) ● FLOODLIGHTING
● TRAFFIC CONTROL SYSTEMS ● AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Atlanta Baton Rouge Birmingham Boston Buffalo Charlotte Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. St. Louis St. Paul Salt Lake City San Francisco Seattle Tulsa Washington

Resident Representatives: Albany Baltimore Reading, Pa. Richmond, Va.

GOULDS

PUMPS FOR INDUSTRY

new way to pump corrosives

ANNOUNCING

a complete new group of vertical process pumps

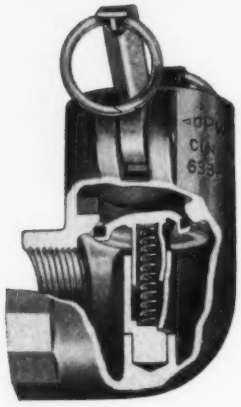
How often would a vertical pump be just the ticket for transfer or other service . . . *except for the fact that you're handling a corrosive liquid?*

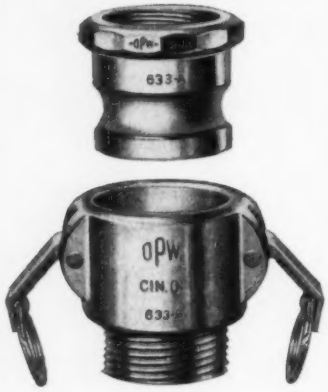
Now you can choose from a complete line of vertical process pumps especially built for heavy-duty service, pumping corrosive liquids. Goulds now offers a wide range of vertical pumps in highly corrosive-resistant materials.

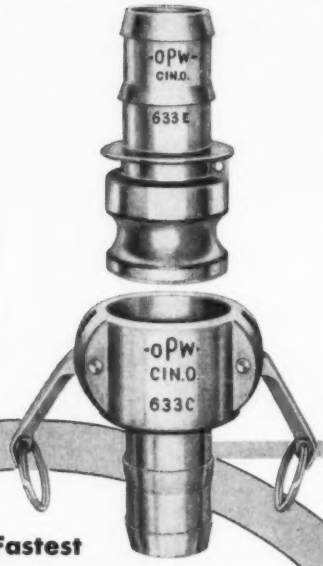
Special constructions available. Standard construction of Goulds new vertical process pumps is 316 stainless steel . . . and other materials to meet your requirements are available on application.

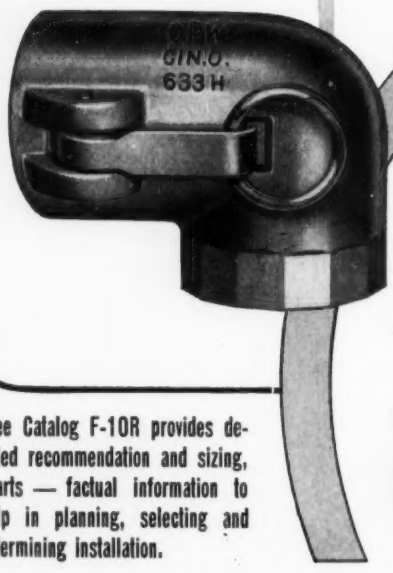
Free bulletin. To discover all the outstanding features of this new line of heavy-duty vertical pumps, contact your nearest Goulds representative and ask for a free copy of Bulletin No. 727-1. Or write to Dept. PR-29, Goulds Pumps, Inc., Seneca Falls, N. Y.

OPW KAMLOK COUPLING ASSEMBLIES









The Fastest

Safest, Surest Coupling Known!

OPW KAMLOKS add extra life to hose . . . guarantee greater security in handling all types of liquids. A perfectly, tight, no-leak seal is made instantly without twisting, kinking or straining of hose. Merely slip Adaptor into Coupler and press cam levers down. No threads to engage, no twisting friction against gaskets, no tools required for a connection that holds fast, stays tight.

OPW KAMLOKS are available in any combination to meet coupling requirements in sizes from ½" to 6" inclusive.

ALL OPW KAMLOKS ARE 100% GAUGED FOR COMPLETE INTERCHANGEABILITY. All styles of Adaptors fit in all styles of Couplers of the same size.

BRONZE • MONEL • ALUMINUM • STAINLESS STEEL • SEMI STEEL

Free Catalog F-10R provides detailed recommendation and sizing, charts — factual information to help in planning, selecting and determining installation.

OPW CORPORATION

2735 Colerain Ave., Cincinnati 25, Ohio, Klrby 1-5400

For more data on advertised products, use Readers' Service Cards, last page.

THERE'S NO STUFFING BOX to adjust or repack on LIGHTNIN Mixers in this butadiene extraction unit at the Orange, Texas plant of The Firestone Tire & Rubber Company. These LIGHTNINs are equipped with easily replaceable mechanical seals.

How to keep a solvent extraction train highballing

A crucial problem facing the engineers who designed this butadiene solvent-extraction train was: how to *keep* it continuous.

In these nine tanks, mechanical mixers were needed to provide intimate contact between the solvent phase and the hydrocarbon phase for quick and complete recovery of butadiene.

But where was a proved mixer design that would keep running for years—without frequent short stoppages for repacking, or costly dismantling in case of a shaft seal failure?

They found the answer in the LIGHTNIN Mixers you see here.

These LIGHTNINs never have to be repacked. Each is equipped with a *mechanical shaft seal that positively prevents leakage*—and runs, not for months, but for *years* without ever needing adjustment.

New shaft seal—in a hurry

Best of all, seal replacement is a fast, simple job.

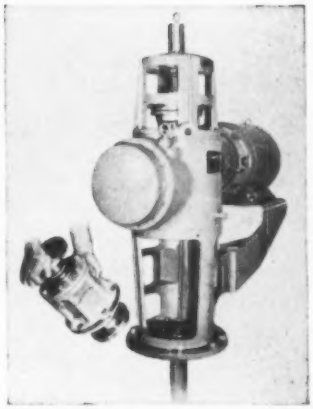
When a seal eventually does wear out, it can be replaced quickly. There's no need to dismantle the mixer or take it off the tank. No need for highly trained personnel, either; any man who can handle a wrench can replace the LIGHTNIN seal.

He merely unbolts two couplings; takes out the seal cartridge as one piece; couples in a new cartridge. Mixer shaft alignment is built-in—need not be checked.

If you're mixing corrosive chemicals under pressure or vacuum, you may save many thousands of maintenance dollars by specifying Series "E" LIGHTNIN Mixers with these quick-change mechanical seals.

You can get LIGHTNINs in hundreds of power-speed combinations, for tanks of any size or shape. Performance is unconditionally guaranteed.

For the full story on increased productivity you get and long-term maintenance savings you make with seal-equipped LIGHTNIN Mixers, call in your LIGHTNIN representative. He's listed in Refinery Catalog. Or write us direct.



CARTRIDGE SEAL runs for years without adjustment . . . and uncouples for rapid replacement.

☐ *Quick! Send us the cost-cutting facts on LIGHTNIN Rotary Mechanical Seals—Bulletin B-111. We'd also like catalog information on these LIGHTNIN Mixers:*

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering propeller type: ¼ to 3 HP (B-103)
- ☐ Side entering; 1 to 25 HP (B-104)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Data sheet for figuring mixer requirements (B-107)

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT CO., Inc., 164-b Mt. Read Blvd., Rochester 3, N.Y.

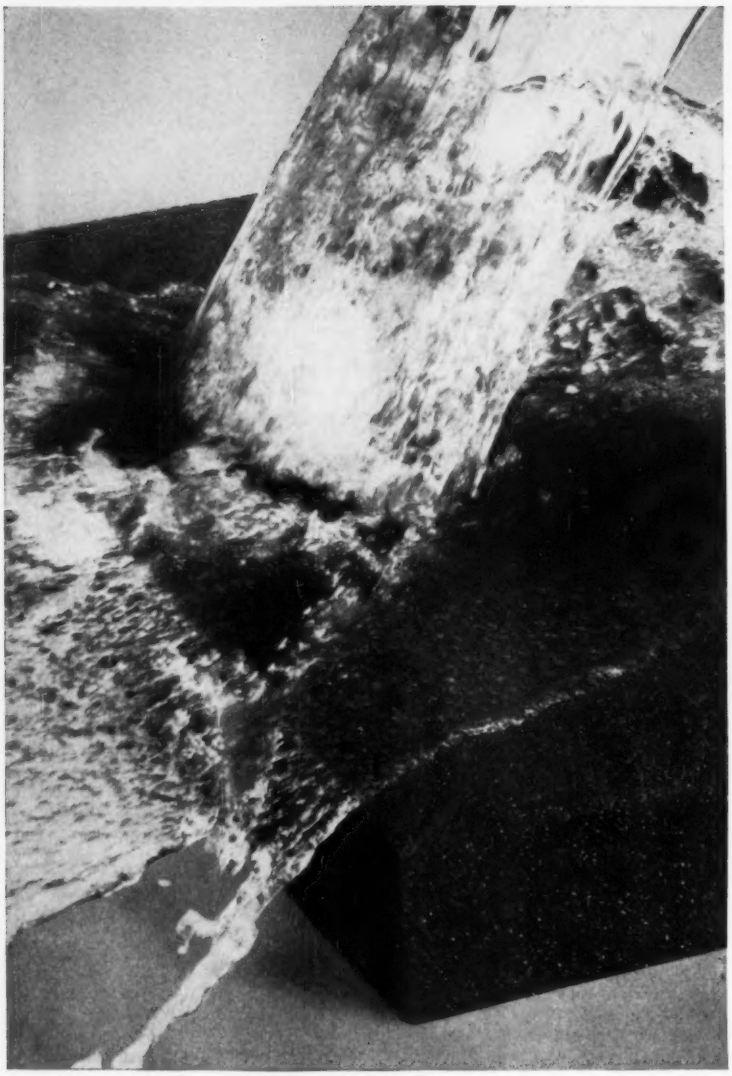
In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Avenue, Toronto 19, Ont.

Lightnin® Mixers

MIXCO fluid mixing specialists

Only cellular glass insulation

FOAMGLAS® IS THE ONLY



Whether you insulate building roofs and walls, piping or equipment, you can seldom anticipate *all* of the conditions to which your insulation will be exposed after installation. Humidity conditions change. Temperature control needs vary. Even the original use for insulated space or equipment may alter. That's why the ideal thermal insulation must give you a *combination* of key benefits . . . in order to serve satisfactorily under all possible conditions.

Most important, the ideal insulation must be impervious to water vapor as well as liquids—in order to insure constant performance under all humidity exposures. It should be proof against acids and acid vapors. It should be incombustible . . . dimensionally stable . . . impervious to vermin . . . strong enough for a variety of structural uses. Just one insulation—cellular glass—meets all of these qualifications.

FOAMGLAS is the only cellular glass insulation.

FOAMGLAS may well be the one satisfactory solution to all your insulating problems. For detailed literature, write—specifying your particular insulation requirements—to Pittsburgh Corning Corporation, Dept. Z-29, One Gateway Center, Pittsburgh 22, Pennsylvania.

PC Glass Blocks and FOAMSIL® are other outstanding products of Pittsburgh Corning.

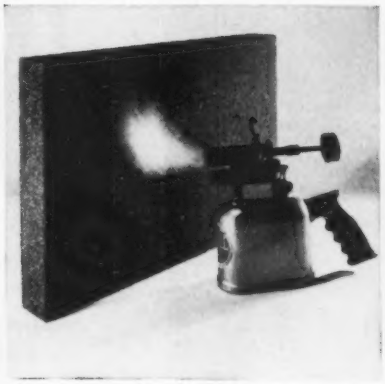
P I T T S B U R G H

For more data on advertised products, use Readers' Service Cards, last page.

gives you all these key benefits

CELLULAR GLASS INSULATION

Moisture-proof! The minute liquid or vapor enters an insulation, it begins to lose its insulating value because moisture conducts heat. FOAMGLAS, a material composed entirely of sealed glass cells, is completely impervious to all moisture. Its K factor—measure of insulating performance—never varies.

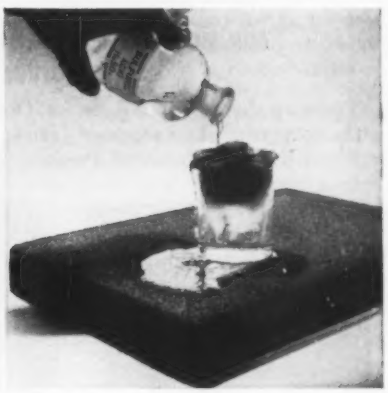


Can't Burn! Smoldering insulation in walls or roof of a building is a deadly fire hazard, hard to detect, difficult to control once detected. FOAMGLAS eliminates this hazard because it is the only insulation composed entirely of incombustible glass. This may even mean lower fire insurance rates in some cases.

Dimensionally Stable! Most insulations tend to warp, swell, shrink or slump after they are installed. This causes open joints in the insulation . . . insulation voids that create a serious loss of efficiency. There is no such difficulty with FOAMGLAS. This all-glass insulation always maintains absolute dimensional stability.

Vermin-proof! Most insulations offer no protection at all against vermin in food processing, storage or handling operations. Rats and other vermin gnaw right through them. FOAMGLAS, on the other hand, affords an excellent vermin barrier. Its all-glass composition offers no food or nesting materials for vermin.

Strongest! FOAMGLAS has a compressive strength of over 7 tons per square foot (av. ult.). It forms a solid base for built-up roofing. It makes possible the placing of insulation beneath heavily loaded floors. And high strength FOAMGLAS permits such cost saving design innovations as free standing walls and partitions.



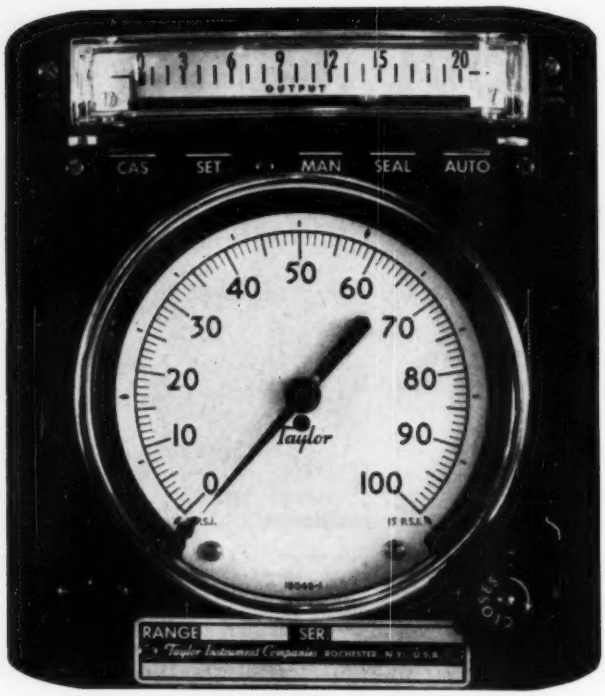
Acid-proof! There is often a lot of acid around a processing operation. Even the atmosphere around processing plants frequently has a high acid content. Acids will attack and destroy most thermal insulating materials, but they won't harm FOAMGLAS. This unique all-glass material is completely impervious to all common acids.

PC CORNING

For more data on advertised products, use Readers' Service Cards, last page.

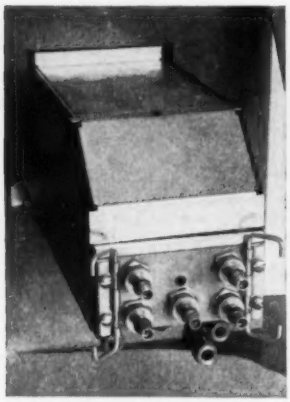
Taylor announces a new low cost

TRANSET* INDICATOR



FOR MOST ECONOMICAL INDICATION AND CONTROL

Team up the new 82KF Series TRANSET Indicator with the SENSAIRE* Temperature Transmitter or the No. 200T Fixed Range Differential Pressure Transmitter.



Rear view, showing plug-in facilities for TRANSCOPE, TRISCOPE or TRANSET Controllers.

Indicator gage snaps in for easy removal without disturbing piping or process control.

This latest addition to the TRANSET family of instruments is designed to permit plug-in mounting of either the bellows type TRANSCOPE*, TRISCOPE* or stacked diaphragm type TRANSET Controllers.

Using accurate, time-proven components, it has exceptionally stable and driftfree set point adjustment. Choice of Bourdon or high accuracy Niafram elements, according to process requirements.

Same cutout as the 66K and 86J TRANSET Indicators and Recorders, and can be quickly adapted to fit the TRANSCOPE Recorder cutout.

Maintenance and servicing is particularly easy. The snap-in indicator gage can be removed for checking without disturbing piping or process control.

Precision adjusting of set point, with regulator having metallic feed-back element and Ni-Span spring, insures stable output even with wide temperature variations.

Piston type selector valves with "O"-ring seals give leakless transfer. Positive positioning is assured by lever switching with definite mechanical stops.

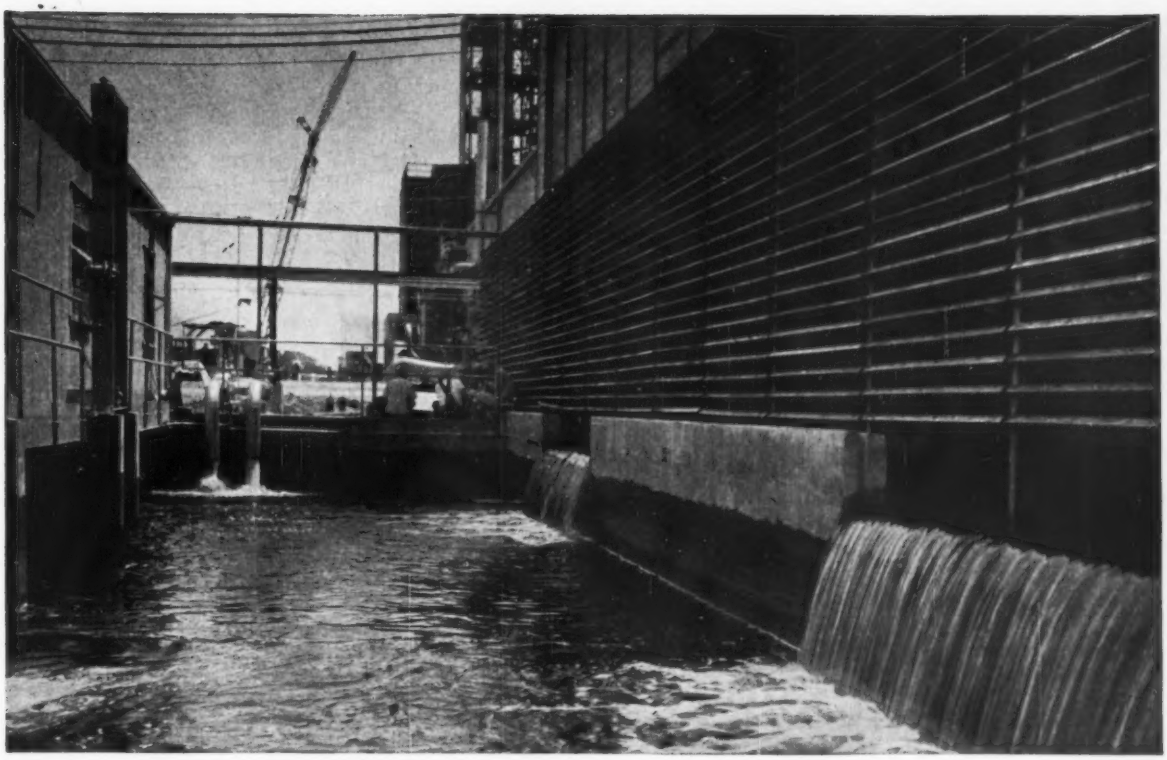
Set point transmitter and switching blocks are the same as used in the famous TRANSCOPE Recorder.

For full details of this precision built but inexpensive instrument see your Taylor Field Engineer or write for information to Taylor Instrument Companies, Rochester, New York or Toronto, Ontario.

*Trade-Mark

Taylor Instruments **MEAN ACCURACY FIRST**

For more data on advertised products, use Readers' Service Cards, last page.



How you can be sure to get the capacity you pay for in a cooling tower...

Thousands of gallons of water pour through a cooling tower every minute. If it goes in hot and comes out cold . . . if it keeps a plant's process water reasonably cool–is it safe to assume that the tower is doing its job . . . that the owner is getting his money's worth out of it?

Definitely not!

A tower may actually be operating at only a portion of the capacity paid for–without the owner's knowledge. Its heat transfer efficiency may fall short of specifications. Operating horsepower requirements may be higher than they should be.

How can you tell?

By conducting thorough field performance tests. But if the tower proves deficient, you can correct it only by increasing horsepower or the size of the tower–or both. Even though the manufacturer stands behind his product, you are put to additional expense, you may lose valuable production because of down time during the reconstruction, and your operating power costs may be increased for the entire life of the tower.

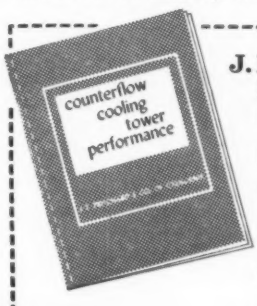
Obviously, the best thing is to *know* the capacity before you buy.

How? Well, you *can* accept the manufacturer's guarantee. But how many manufacturers *really* know? Determining the capability of a cooling tower is an exacting science, requiring highly specialized knowledge of a wide variety of factors influencing performance.

Portions of such knowledge have been published in the past but much has been retained by cooling tower manufacturers as "private and confidential" data. But now, Pritchard has gathered all this information, refined it, added to it field-tested findings from our own research facilities, and arranged it into usable form. This reservoir of knowledge has been published under the title, "Counterflow Cooling Tower Performance," and is available from Pritchard for $3.00. For your copy, mail the coupon below with your check or money order.

No book alone, however, can guarantee cooling tower capacity. That is the responsibility of experienced Pritchard engineers, who translate the information contained in the handbook into cooling tower designs that give you performance, not promises . . . real long-run economy, not first-cost-only economy.

The result is that when you buy from Pritchard, you buy with full confidence that you get what you pay for. You can rest assured that your Pritchard tower will deliver the capacity you specify.



J. F. PRITCHARD & CO. OF CALIFORNIA

Dept. 115, 4625 Roanoke Parkway, Kansas City 12, Mo.

- ☐ Enclosed is $3.00. Please send copy of "Counterflow Cooling Tower Performance"
- ☐ Please send free copy of new Counterflow Cooling Tower Bulletin 4.9.080A
- ☐ Please have your representative call on me

Name..... Title.....

Firm.....

Address.....

City..... Zone..... State.....

For more data on advertised products, use Readers' Service Cards, last page.

To refiners who need more

HYDROGEN
FOR HYDROTREATING

Any refiner who needs more hydrogen can now arrange to make up the deficiency with generating facilities of his own.

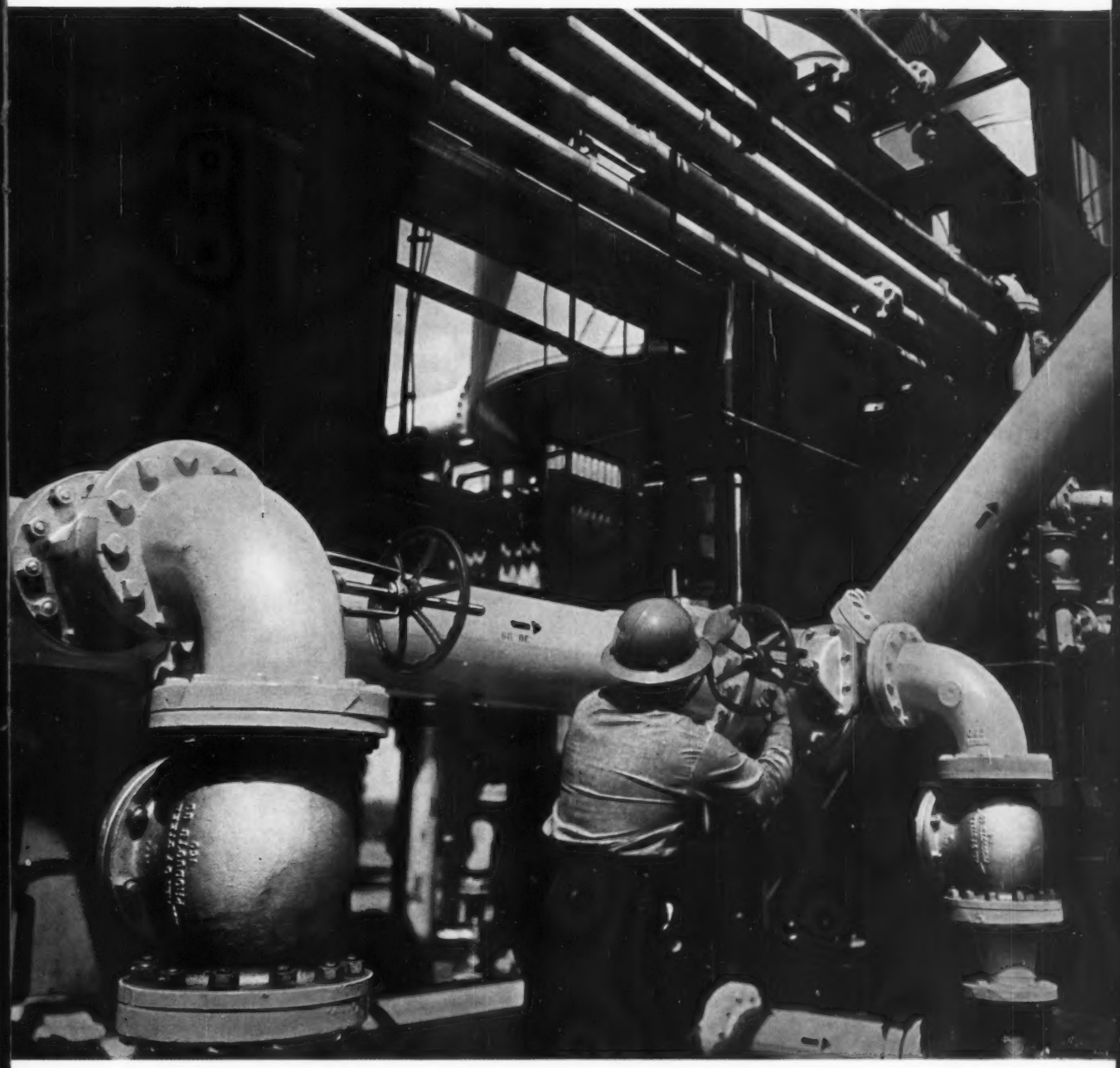
Procon is prepared to design, engineer and build a hydrogen plant to suit your needs. Two types of packaged hydrogen plants, capable of utilizing a broad range of hydrocarbons as feed stocks, can be supplied. Catalytic Steam Reforming of light hydrocarbons forms the basis for one type. The other employs Partial Oxidation of heavy fuel oils. With either type, the plant will be designed to produce hydrogen of the purity needed for hydrotreating—and to provide maximum thermal efficiency.

Procon engineers will be glad to consult with you.

PROCON *Incorporated*

1111 MT. PROSPECT ROAD, DES PLAINES, ILL., U.S.A.
PROCON (CANADA) LIMITED, TORONTO 18, ONTARIO, CANADA
PROCON (GREAT BRITAIN) LIMITED, LONDON, W. C. 2, ENGLAND
PROCON INTERNATIONAL S. A., SANTIAGO DE CUBA

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL AND CHEMICAL INDUSTRIES



Aloyco Valves in General Chemical's new "dream" plant

The Aloyco Valves you see here are controlling the flow of 98% acid in the new sulfuric acid plant of General Chemical Division, Allied Chemical Corporation, at Elizabeth, New Jersey.

The plant utilizes most modern processing techniques. All equipment was chosen for its special ability to contribute to operating efficiency and long life.

For example, valves made in Aloyco 20, an alloy exceptionally resistant to corrosion from sulfuric acid, were specified for handling spent and sludge acids, as well as finished strong acid and oleum.

When you are selecting valves for corrosive service, remember only Alloy Steel Products Co. specializes in Stainless Steel Valves exclusively. Call our local representative or write us at 1301 West Elizabeth Avenue, Linden, N. J. 9.2

ALLOY STEEL PRODUCTS COMPANY

Boston · New York · Wilmington · Atlanta · Buffalo · Pittsburgh · Chicago · St. Louis · San Francisco · Los Angeles

"An investor is not an exploiter. The modern enlightened political concepts of the free world make economic imperialism impossible. An investment is good only if it is mutually beneficial to the investor and the people of the host country. While the investor expects a return on the investment, the additional capital generated is plowed back into the host country to underwrite the continuation of industrial development."

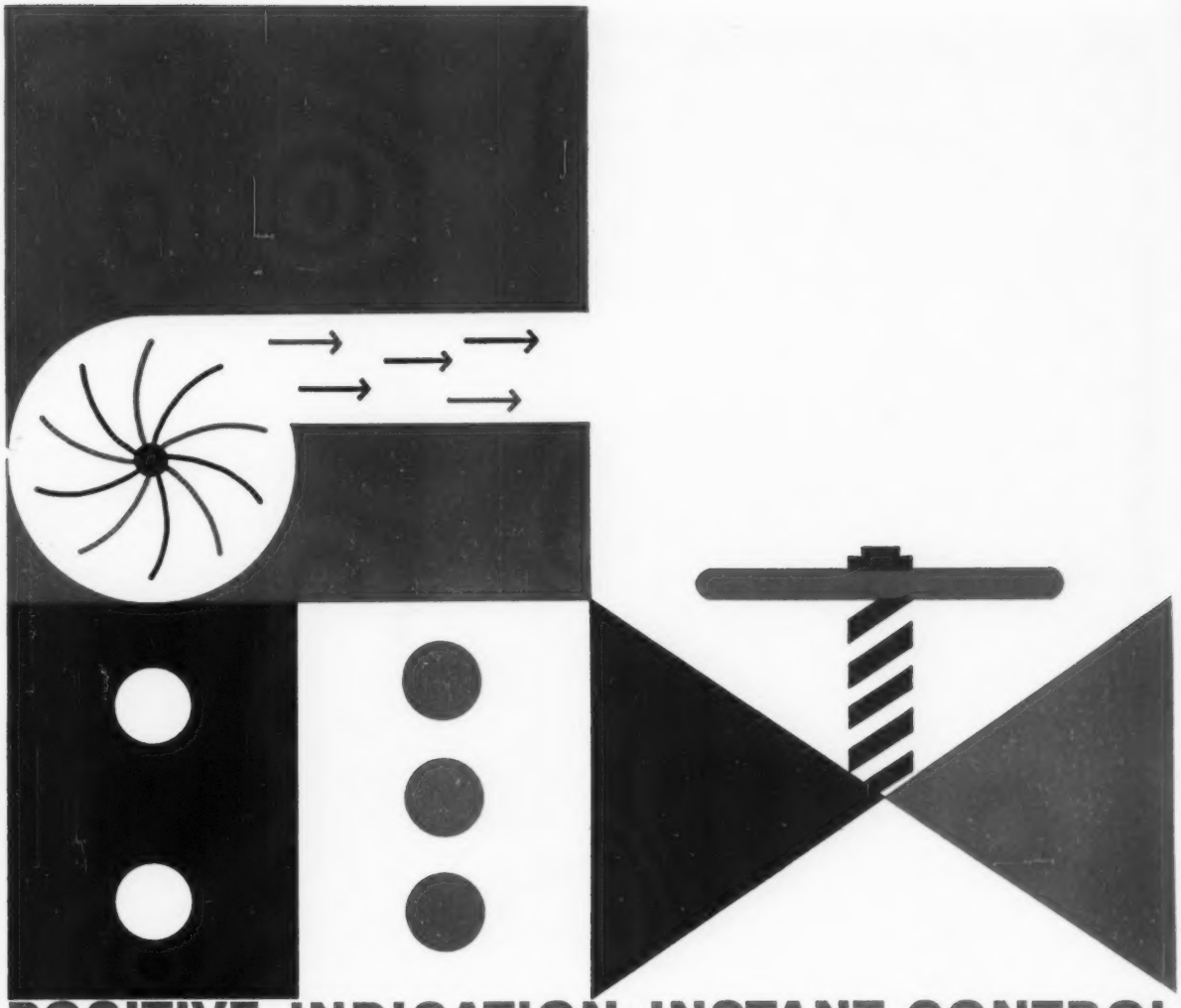
Eugene Holman, Chairman of the Board, Standard Oil Company (New Jersey)

ESSO

STANDARD OIL COMPANY (NEW JERSEY)

AND AFFILIATED COMPANIES

For more data on advertised products, use Readers' Service Cards, last page.



POSITIVE INDICATION-INSTANT CONTROL OF REMOTE PUMP MOTORS AND VALVES

S&J Gardtrol units continuously report actual conditions at remote points. They also allow instant change of conditions by the operator. Gardtrol Valve Monitor shows open, opening, closing, closed or stopped (partly closed) conditions. Gardtrol Pump Motor Monitor indicates on or off. Both have simple illuminated push button controls for all functions. Only one small wire—plus a common return—is needed between control unit and the field unit. S&J Gardtrol assures reliable supervisory control at lowest cost.

SHAND AND JURS

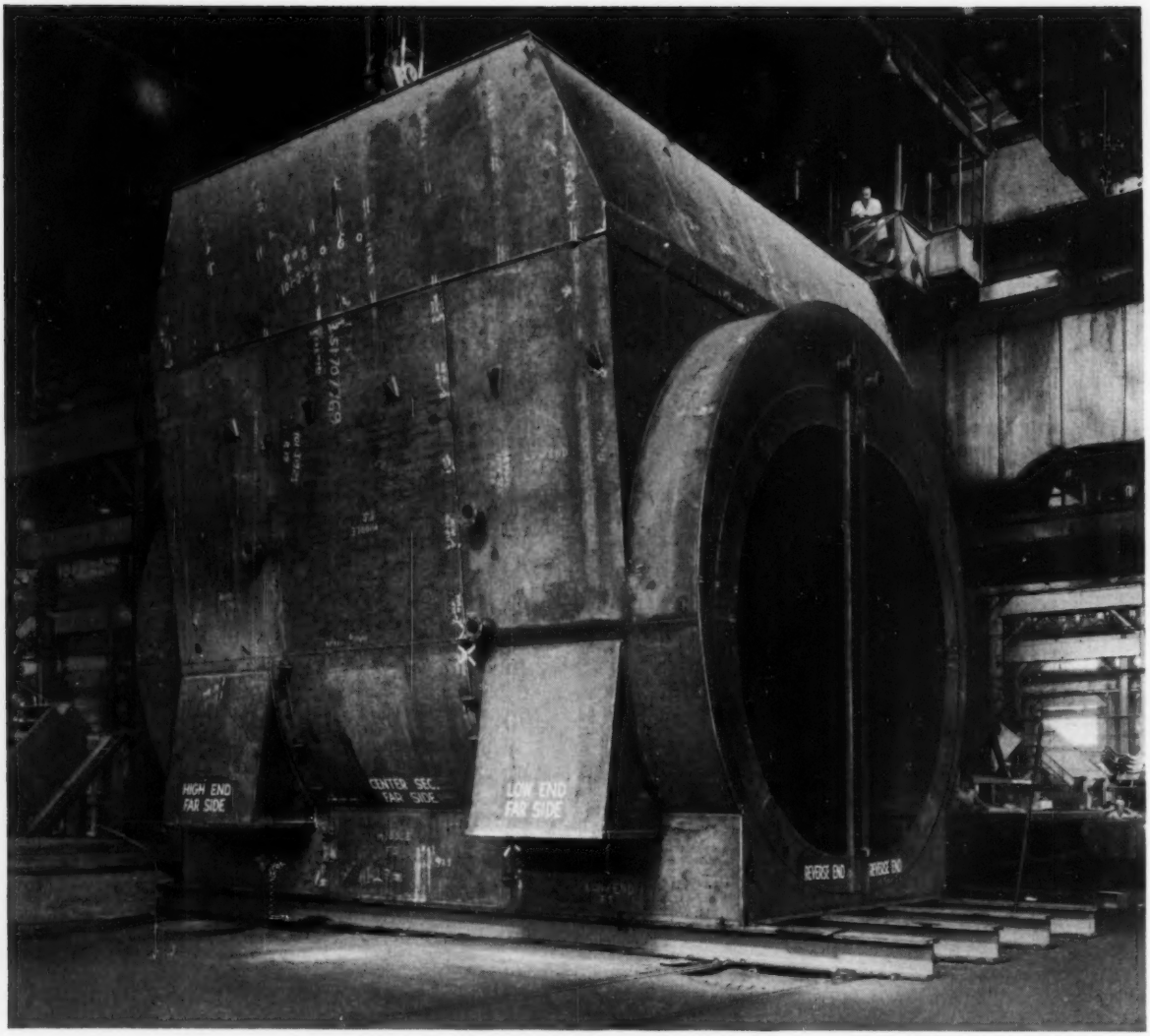
SHAND AND JURS COMPANY 2600 Eighth Street, Berkeley, California

A Subsidiary of General Precision Equipment Corporation

Branch offices and representatives in principal cities

For more data on advertised products, use Readers' Service Cards, last page.

LINDE packaged oxygen plant



Operator of overhead crane (top, right) and workmen on shop floor are dwarfed by the enormousness of this surface condenser casing fabricated by B-L-H's Eddystone Division.

No welding job too big for vast B-L-H facilities

No welding job—not even the biggest pressure vessels—is too large for the facilities of Baldwin-Lima-Hamilton's Eddystone Division. The fabricating shop covers 15 acres and is divided into 13 bays, each 80 ft. wide and 600 ft. long.

Sheer size does not, of course, even begin to tell the whole story. From automatic tracer flame cutters to individual hand welders, we have a tool for every conceivable operation. And there is no reason for you to spend money transporting formed parts to Eddystone for welding—or completed weldments to some other shop for machining. We can handle every phase of the job—from design right through to delivery. No wonder so many companies bring the big ones to B-L-H.

Our illustrated Weldment Bulletin 7001 will give you an excellent idea of our vast facilities. You should have it in your files. For a copy, write to B-L-H Corporation, Philadelphia 42, Pa.

BALDWIN · LIMA · HAMILTON

Eddystone Division

Philadelphia 42, Pa.

Hydraulic turbines • Weldments • Dump cars • Nonferrous castings • Special machinery • Bending rolls • Machine tools

LINDE packaged oxygen plant sets nine-year record for availability!

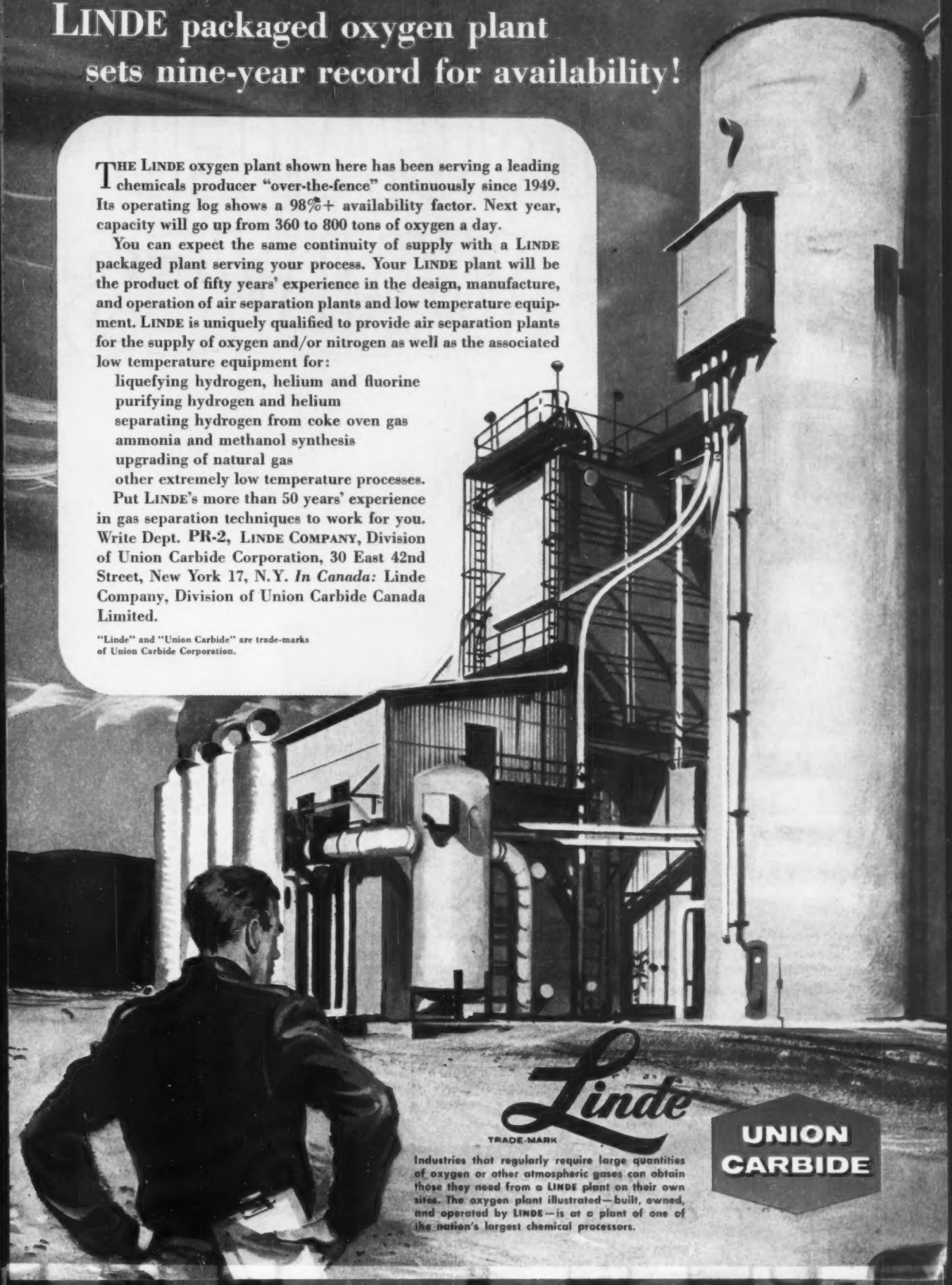
THE LINDE oxygen plant shown here has been serving a leading chemicals producer "over-the-fence" continuously since 1949. Its operating log shows a 98%+ availability factor. Next year, capacity will go up from 360 to 800 tons of oxygen a day.

You can expect the same continuity of supply with a LINDE packaged plant serving your process. Your LINDE plant will be the product of fifty years' experience in the design, manufacture, and operation of air separation plants and low temperature equipment. LINDE is uniquely qualified to provide air separation plants for the supply of oxygen and/or nitrogen as well as the associated low temperature equipment for:

liquefying hydrogen, helium and fluorine
purifying hydrogen and helium
separating hydrogen from coke oven gas
ammonia and methanol synthesis
upgrading of natural gas
other extremely low temperature processes.

Put LINDE's more than 50 years' experience in gas separation techniques to work for you. Write Dept. PR-2, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

"Linde" and "Union Carbide" are trade-marks of Union Carbide Corporation.



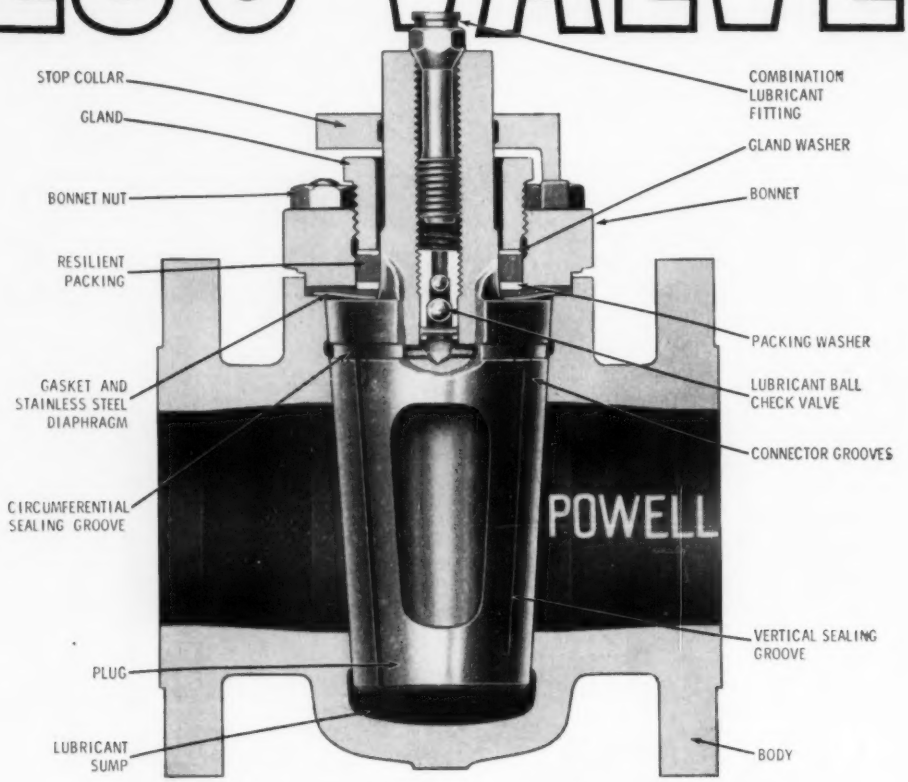
Linde
TRADE-MARK

UNION CARBIDE

Industries that regularly require large quantities of oxygen or other atmospheric gases can obtain those they need from a LINDE plant on their own sites. The oxygen plant illustrated—built, owned, and operated by LINDE—is at a plant of one of the nation's largest chemical processors.

POWELL

LUBRICATED PLUG VALVES



Sectional view Powell Screwed Gland Lubricated Plug Valve.

Like all Powell Valves, Powell Lubricated Plug Valves are superior in their field . . . and have many advantages over other conventional types of Valves.

- Simple design: only three basic parts—Body, Bonnet, Plug.
- Quick, complete shut-off—a quarter turn will close or open the valve.
- Tapered Plug assures positive seating.
- Machined surfaces of plug and body are not exposed in the open position. Any media adhering to the plug when in the closed position is removed when plug is rotated.
- Cavity-free straight passage assures streamlined flow in either direction. Scale and sediment cannot collect.

Powell Lubricated Plug Valves are available in sizes $\frac{1}{2}$" through 16", depending on the type required—Semi-steel 175 and 200 pounds WOG;—Carbon Steel ASA 150 and 300 pounds.

Powell can also furnish Lubricated Plug Valves in other alloys on special order.

For all your valve needs, make it a policy to consult your local Powell Distributor—or write directly to us.

THE WM. POWELL COMPANY

Dependable Valves Since 1846 • Cincinnati 22, Ohio

For more data on advertised products, use Readers' Service Cards, last page.

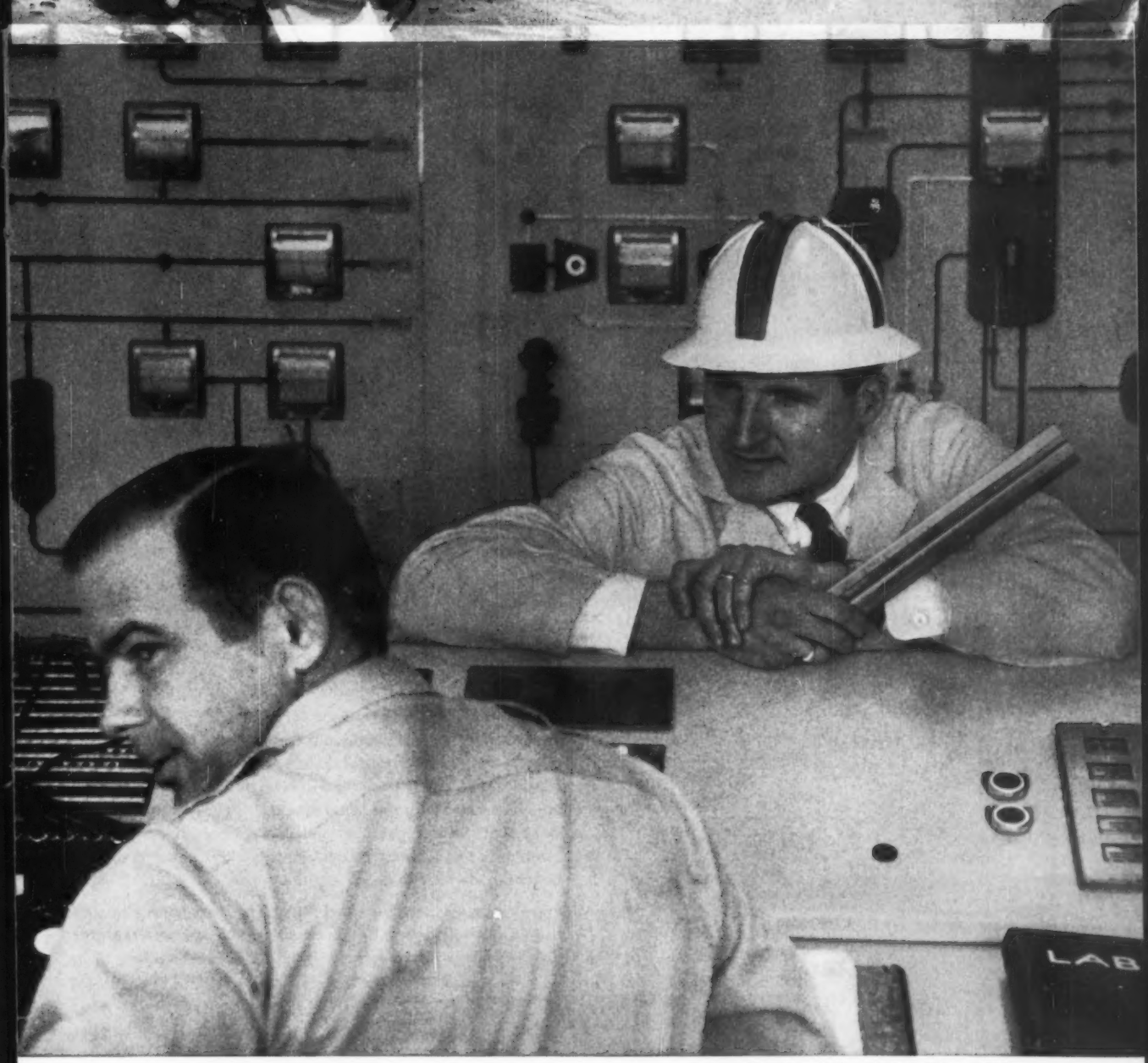


Photo taken at Delaware Refinery, Tidewater Oil Company

At the controls of refining progress

Refining progress and chemical technology go hand in hand. Working with refiners, Cyanamid chemists helped to pioneer the development of synthetic fluid cracking catalysts and the first fully regenerative platinum reforming catalyst. Behind Cyanamid's service as a major catalyst producer are its unlimited resources as a major chemical producer. To lend a hand in further progress, Cyanamid's man with the golden rule can place at your disposal vast chemical research and development facilities.

Basic in Catalyst Chemistry

CYANAMID

AMERICAN CYANAMID COMPANY • REFINERY CHEMICALS DEPARTMENT • 30 Rockefeller Plaza, New York 20, N. Y.

Originators of AEROCAT® Fluid Cracking Catalysts, AEROCAT TRIPLE A® High Alumina Catalysts, AEROCAT® 2000 Fluid Cracking Catalyst, AEROFORM® Fluid Hydroforming and Platinum Reforming Catalysts, AERO® HDS Catalysts, AERO® Specialty Catalysts, CYPAN® Drilling Mud Conditioner, AEROLUBE® Lubricating Oil Additives, AERONOX® Antioxidants, AEROSOL® Surface Active Agents.

"SPECIAL" Welding Fittings

by MIDWEST

"SPECIAL" DESIGNS

"SPECIAL" MATERIALS

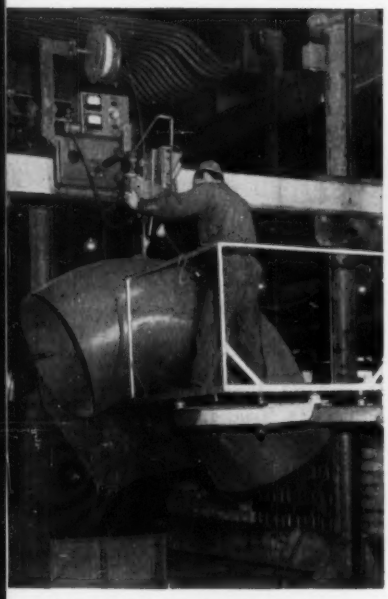
"SPECIAL" QUALITY

"SPECIAL" DELIVERY

Special gauges and instruments are used to make sure that we have complied with the extremely close tolerances often required on stainless fittings. Here wall thickness and concentricity were held within extremely close limits throughout the fittings.

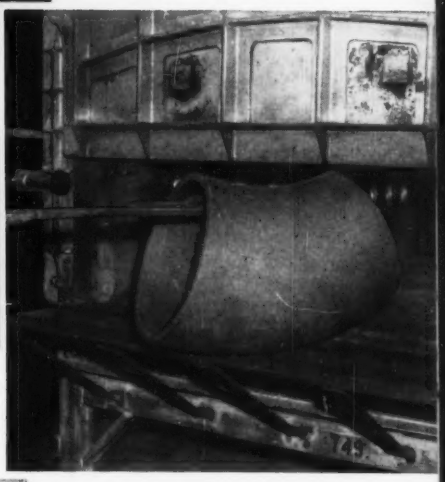
The exclusive Midwest method of manufacture—much more versatile and flexible than any other—enables us to make almost any type of special welding fittings to the most rigid specifications. Midwest makes welding fittings from *plate* . . . usually much easier to get than pipe, particularly if the material is special. That expedites delivery. Closer tolerances are inherent in the Midwest process, and quality control is always beyond code requirements.

Even if you use only standard fittings, the exceptional quality of Midwest fittings can be important to you. Ask your Midwest distributor or write us for new Bulletin 5801.



36" O.D. 90° elbow with 16" tangent on one end being welded by an automatic submerged arc machine. Material is A-201 carbon steel.

Stainless-clad elbows undergoing ultrasonic inspection to check bonding of material and quality of weld. Since plate is often the only form in which clad material is available, the Midwest process is able to produce the most comprehensive range of clad fittings—and to do so promptly.



Special 24" x 21" 45° reducing elbow made of 1" thick 1¼% chrome ½% moly steel ready for heat treating furnace.

MIDWEST PIPING COMPANY, INC.

Main Office: St. Louis 3, Mo. (P. O. Box 433)

PLANTS: ST. LOUIS, CLIFTON, N. J. and LOS ANGELES

SALES OFFICES:

Asheville (Box 446, Skyland, N.C.) • Atlanta 9–72 11th N.E. • Boston 27–426 First St. • Chicago 3–79 West Monroe St. • Cleveland 14–616 St. Clair • Houston 2–1213 Capitol • Los Angeles 33–520 Anderson • Miami 34–2103 Le Jeune • New York 7–50 Church St. • Pittsburgh 19, Pa. –437 Grant • San Francisco 11–420 Market St. • St. Louis 4, Mo.–1450 South Second St. • Tulsa–1640 E. 21st St.

STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

8059

Oakite ECP
engineered cleaning program

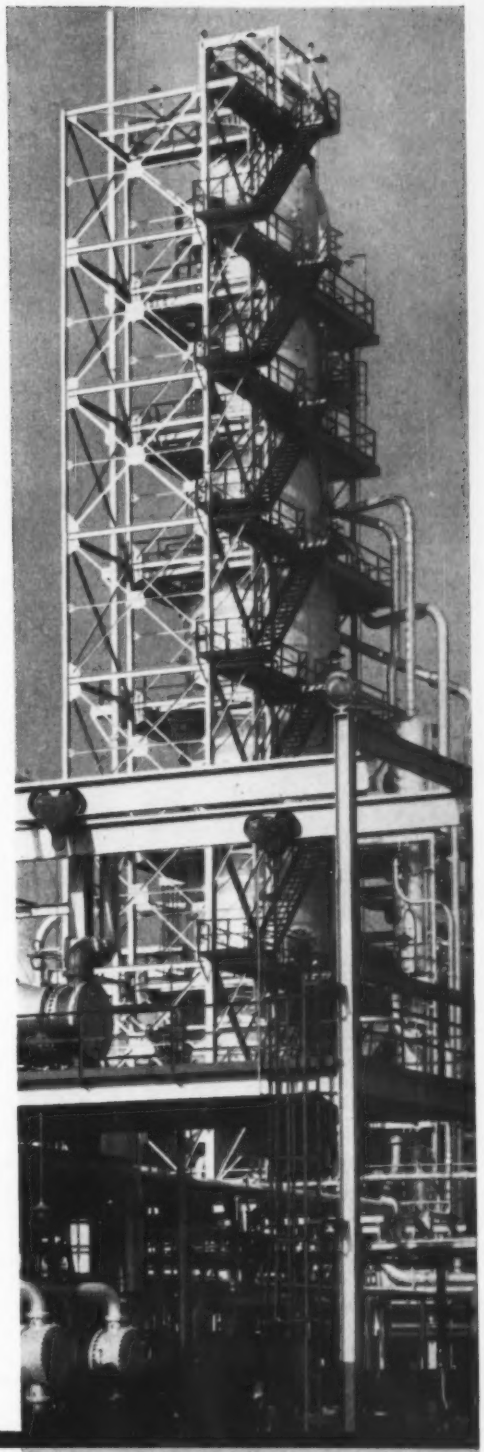
gets crude tower nearly 100% clean

Could results as good as 85% clean be made even better in clearing crude oil deposits from vacuum tower? The Oakite engineer thought so. He revised one refinery's ECP*.

For next turnaround, he recommended circulating a solution of Oakite 77 and Oakite 8 through the tower. Meanwhile, heat exchangers below were soaked and steamed. Then reversing procedure the solution circulated through the heat exchangers while tower was steamed. This kept up for 15 hours—followed by rinsing and inspection. Results: *99% perfect.* Hosing knocked off the last remaining bits of soil. In just 21 hours, tower and exchangers were cleaner than they'd ever been.

WHAT IS OAKITE ECP* It's an *Engineered Cleaning Program* that stresses chemical cleaning. It's engineered specifically for your refinery, for your cleaning problems, and for each cleaning operation —tower to tank.

The Oakite specialist lends his personal cooperation and practical knowledge of refinery cleaning needs. Each Oakite ECP is backed by a *laboratory* concentrating on chemical cleaning research, by *materials* known to make short work of refinery soils, by proved *methods,* by detailed *engineering data.* Send for Bulletins. Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.



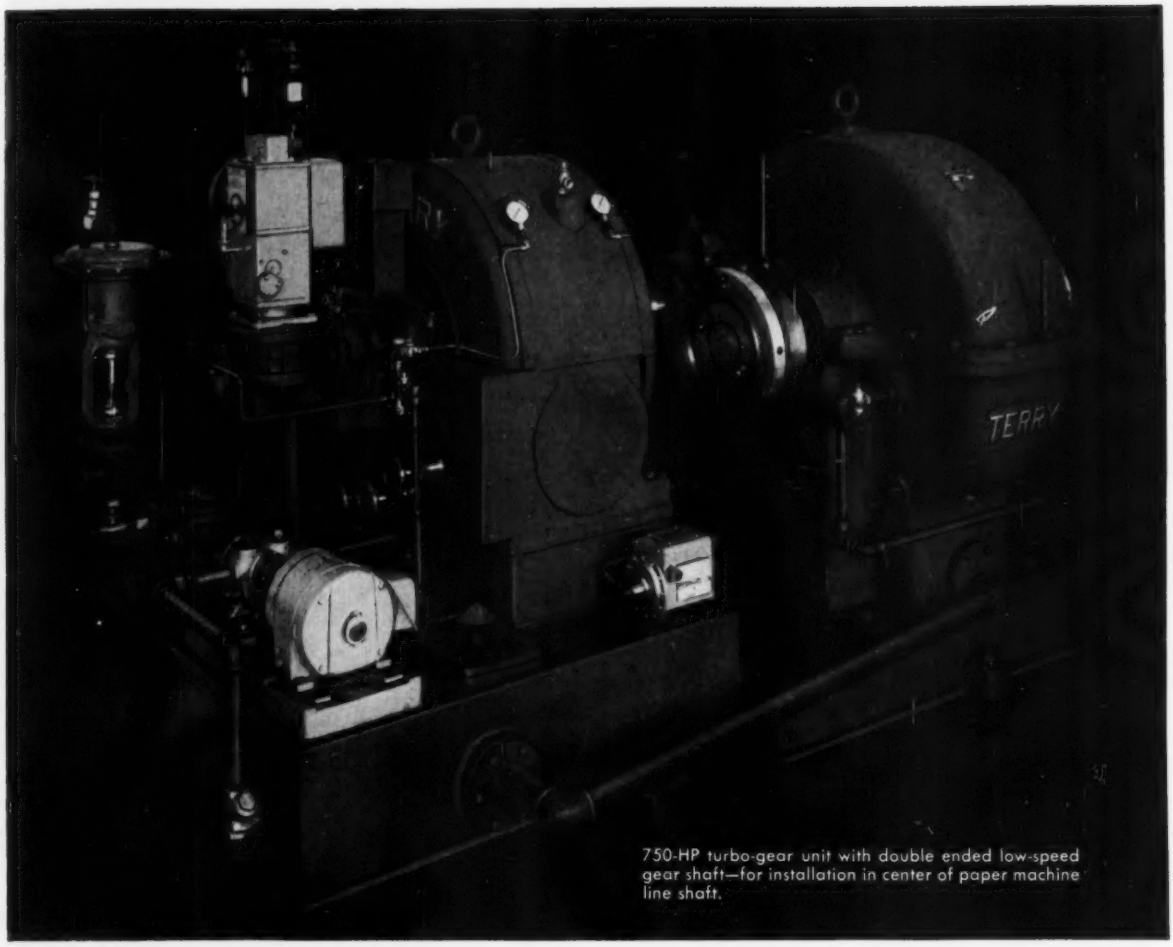
OAKITE
50 1909-1959 SCIENCE
years' leadership in industrial cleaning

Export Division Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

Oakite ECP
your economy key

For more data on advertised products, use Readers' Service Cards, last page.



750-HP turbo-gear unit with double ended low-speed gear shaft—for installation in center of paper machine line shaft.

LOW-SPEED TURBINE DRIVES

tailored to meet your requirements

For more than half a century, Terry has been one of the principal suppliers of turbo-gear units for driving slow-speed fans, generators, paper machines, large pumps and the like. Each unit is designed to meet the job requirements. The paper-machine drive illustrated is a good example of this *individualized engineering.*

In service at a large southeastern paper mill, the unit delivers 750 HP at 3350/500 RPM, with steam conditions of 450 lbs., 660°F and 50 lbs. back pressure. Equipped with a variable-speed governor, operated by remote control, the speed of the unit may be varied through a 10:1 range. Other features include forced-feed lubrication to turbine and gear bearings, and automatic shutdown and alarm in case of low oil pressure.

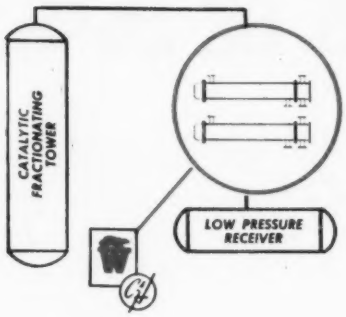
Whatever *your* requirements for low-speed turbine drives, a Terry engineer will be pleased to discuss them with you. Bulletin S-140 covers the full line of Terry turbines; Terry gears are described in bulletin S-130.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1212

For more data on advertised products, use Readers' Service Cards, last page.



NEW "CAT" FRACTIONATOR OVERHEAD CONDENSERS TUBED WITH WOLVERINE TRUFIN® TYPE S/T CONDENSER TUBE

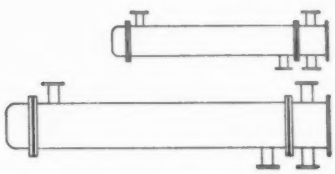
Because of Wolverine Trufin Type S/T condenser tube, new standards of efficiency and economy are daily being established in the field of heat transfer. Diagramed above is another Trufin installation—this time the condensing, for a large Midwest refinery, of hydrocarbon overhead vapors from a catalytic cracking unit fractionating tower.

Illustrated here are four solid reasons why this company specified Trufin Type S/T for the job.

Wolverine Trufin Type S/T will work exactly the same for you as it does for this company. Put it to the test—specify it next time you retube existing equipment or are contemplating the design of new units. Write today for your copy of the Process Flowsheet booklet—it's filled with helpful design information.

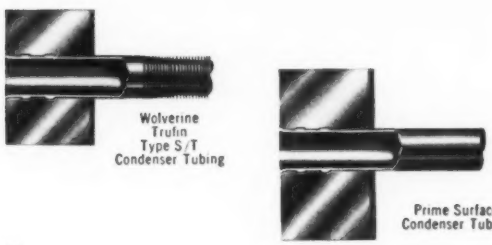
1

INCREASED EFFICIENCY—Trufin Type S/T is an extended surface tube with its fins an integral part of the tube wall. Because of this, Type S/T has more than two times the heat transfer surface of prime surface tube—extracts more BTU's per foot of tube. Shown here are comparable lengths of tube for equivalent heat transfer surfaces.



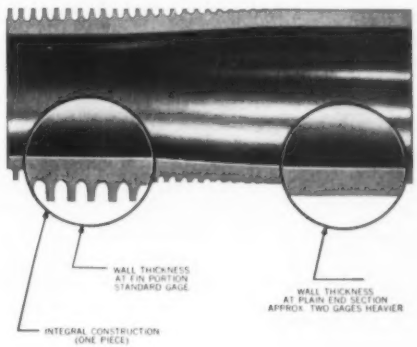
2

LOWER COST—Type S/T's additional outside surface area permits the use of less tube for a given heat duty. You get smaller shells, baffles, reduce fabricating costs with lower maintenance because there are less tubes to clean.



3

EASY INSTALLATION—Trufin Type S/T rolls into headers as easily as plain tube—uses the same fabrication methods. Standard rolling-in tools are used. There is no deviation from existing fabrication procedures.


WALL THICKNESS AT FIN PORTION STANDARD GAGE
WALL THICKNESS AT PLAIN END SECTION APPROX. TWO GAGES HEAVIER
INTEGRAL CONSTRUCTION (ONE PIECE)

4

ENGINEERED FOR THE JOB—Trufin Type S/T is specifically designed for shell and tube applications. The cutaway photograph illustrates its unique, one-piece construction. Because of this, Type S/T gives constant efficiency—its fins are unaffected by thermal shock, vibration or varying pressures.

CALUMET & HECLA, INC.
CALUMET DIVISION
URANIUM DIVISION
GOODMAN LUMBER DIVISION
WOLVERINE TUBE DIVISION
In Canada:
CALUMET & HECLA OF CANADA LIMITED
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO. LTD.
UNIFIN TUBE DIVISION

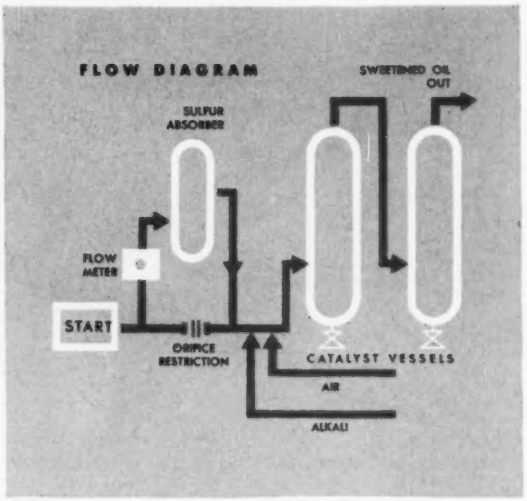
WOLVERINE TUBE
DIVISION OF
CALUMET & HECLA, INC.
17236 Southfield Road
Allen Park, Michigan
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES

PRODUCT IMPROVEMENT WITH

PETRECO



IF SWEETENING IS ONE OF YOUR REFINERY PROBLEMS...

these facts about PETRECO* BENDER Catalytic Sweetening† may show you the answer:

LOW OPERATING COSTS: The average treating costs of Petreco Bender treating units are about 0.5 cents per barrel. Copper chloride or doctor treating costs, exclusive of amortization, generally exceed 1.0 cents per barrel. *The value of the volume loss in doctor treating alone often exceeds the total operation and amortization costs of Petreco Bender catalytic sweetening.*

SWEET NON-CORROSIVE PRODUCT: As compared to doctor treating, less sulfur is used, resulting in the delivery of a consistently non-corrosive product. *The use of less sulfur also lessens octane loss.*

ELIMINATES AIR AND WATER POLLUTION: Processing is in a closed system, eliminating air pollution and the attendant safety hazards. This eliminates open batch type agitators, thereby assisting in safety programs. *There is no "black strap" carry-over or carry-under to contaminate waste disposal systems.*

The product from the Petreco Bender unit is low in trace metal ions. Where a water wash is required to meet local product specifications, emulsion problems are not encountered due to the cleanliness of the Bender treated oil.

The only spent alkali withdrawn from the Bender unit each day is the small amount not consumed in the process.

HIGH YIELD: There is no volume loss in the system other than sampling and spillage. The volume loss in other sweetening processes is the greatest expense factor.

CONTINUOUS REGENERATION NOT NECESSARY: The catalyst retains its activity for long periods of time. This is made possible by the continuous addition of small quantities of air and alkali. Catalyst life without reactivation is usually two years or more. *Two Petreco Bender plants have been operating for over three years without any reactivation of the original catalyst.*

LOW INSTALLATION COST: *Unit cost for new equipment is comparatively low, ranging from $15 to $30 per barrel of daily throughput capacity.* If existing vessels are available and appropriate for conversion, this cost can be substantially reduced. Very often the charge may be taken directly from a distillation unit with existing pumps, exchangers and instrumentation, reducing the installation cost further.

SMALL TREATING AREA REQUIRED: Where ground areas are congested, the area occupied by any treating unit is of great importance. The plot dimensions for a 5,000 bpd Petreco Bender unit, for example, would be approximately 20′ x 35′.

† *For middle range distillate streams such as kerosine, stove oil, light gas oil, No. 2 fuel oil, coker naphtha and catalytic gasoline.*

*PETRECO *is a registered trademark of Petrolite Corporation.*

BSD-1

PETROLITE CORPORATION

PETRECO DIVISION
3202 South Wayside Drive (P.O. Box 2546), Houston 1, Texas
1390 East Burnett Street (P.O. Box 7216), Long Beach 7, California

CANADA: Petreco, 4528 Stanley Drive, Calgary, Alberta
COLOMBIA: South American Petrolite Corporation, Calle 19, No. 7-30, Office 807, Bogota
ENGLAND: Petrolite Limited, 46 Mount Street, London, W. 1.
VENEZUELA: South American Petrolite Corporation, Hotel Avila, Caracas

REPRESENTATIVES

BRAZIL: WERCO, Ltda., Rua General Gurjao 326, Rio de Janeiro
ITALY: O. Wagner, 149 Via Nemorense, Apt. 1, Rome, Italy
JAPAN: Chiyoda Chemical Engineering and Construction Company, Ltd., Tokyo Bldg., No. 3, Marunouchi 2-Chome, Chiyoda-Ku, Tokyo, Japan
KUWAIT: F. N. Dahdah, Box 1713, Al Kuwait
MEXICO: R. E. Power, Sierra de Mijes, No. 125, Mexico D. F.
NETHERLANDS: F. E. C. Jenkins, Hoefbladlaan 134, The Hague
TRINIDAD: Neal and Massy, Ltd., Port of Spain, P. O. Box 544

DEKORON
PROTECTO-PAC

Advantages of Dekoron all-plastic instrument tubing harness are *now four-dimensional.* You get, in addition to its inherent lower-cost installation . . . chemical . . . impact . . . fire resistance.

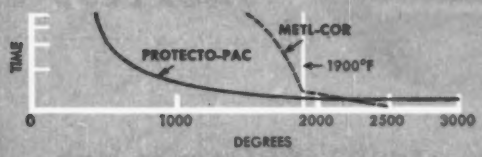
And the advantages of Dekoron Protecto-Pac multiply the closer you examine them. For example, you can get Protecto-Pac in many forms to suit your requirements exactly — *from stock.*

If there is danger from weld splatter, sparks or a potential fire hazard — order Dekoron Protecto-Pac Type FB. If you wish to bury it underground — specify low-cost Protecto-Pac Type B. Both types supplied with virtually any number of individual tubes, and also with *new metal armor protection.*

You can pay more but you can't buy better, longer-lasting instrument line harness than *Dekoron — America's Premier Instrument Tubing Line.*

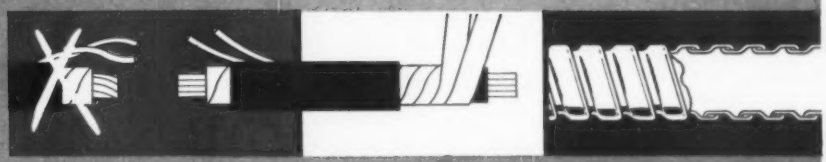
AA-8139

TYPE FB
FOR FIRE AND IMPACT RESISTANCE



FIRE RESISTANCE of copper tube bundles is superior up to 1900°F; less pronounced from 1900° to 2500°F. Above 2500° Protecto-Pac Type FB is superior to copper tube bundle.

TYPE B
FOR UNDERGROUND BURIAL



NO "CORKSCREW" effect, as with twisted tubes, because tubes lie straight in bundle to give faster, neater individual tube take-offs.

NEW IMPROVED INSULATION is composed of two wraps of asbestos tape bonded to backing of Mylar® for maximum protection.

DEKORON PROTECTO-PAC Type FB or Type B can be supplied with 24 gauge galvanized steel armor of modified square-lock construction with cord packing for maximum strength and flexibility.

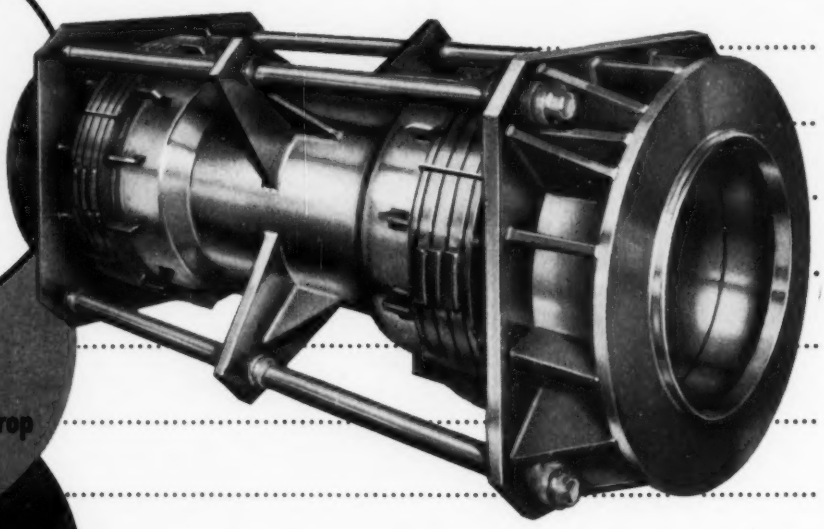
Dekoron® products QUALITY • RESEARCH • SERVICE

SAMUEL MOORE & COMPANY • DEKORON PRODUCTS DIVISION • MANTUA, OHIO

For more data on advertised products, use Readers' Service Cards, last page.

for Piping Protection Plus

+ lower heat loss
+ minimum space
+ lower pressure drop
+ minimum cost



Specify ADSCO

CORRUFLEX®

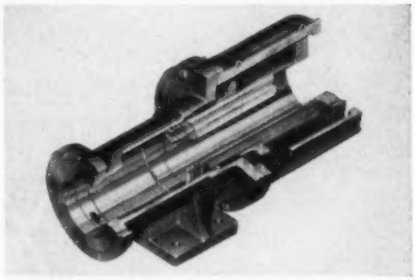
PACKLESS EXPANSION JOINTS

Designed for a 30″ diameter high pressure, high temperature service line in a southwestern aircraft and missiles engine test center, the Adsco CORRUFLEX Self-equalizing stainless steel Expansion Joint shown above is one of many custom-designed units in service.

Adsco CORRUFLEX Expansion Joints are manufactured in sizes of 3″ or larger, designed for specific line conditions. These units provide maintenance-free, trouble-free service.

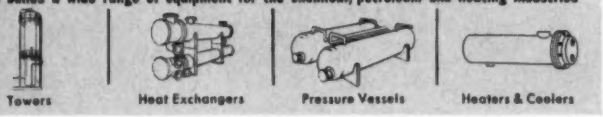
Every possible combination of pipe motion can be fully compensated for – absorption of axial motion, lateral deflection and angular rotation – with one or more standard or custom-engineered CORRUFLEX packless joints built by Adsco.

For complete engineering data write for your copy of the new CORRUFLEX Expansion Joint Bulletin, No. EJ-59-50 on your company letterhead.



ADSCO Piston-ring Slip-type Expansion Joints are world renowned as the only joints which can be unpacked and completely repacked without shutting down line pressure. As the *only* manufacturer of both slip and packless expansion joints, Adsco recommends the proper type which is best suited to the demands of the job – your assurance of complete satisfaction, utmost economy.

Yuba builds a wide range of equipment for the chemical, petroleum and heating industries



Adsco Division • 20 Milburn St., Buffalo 12, N. Y.

YUBA CONSOLIDATED INDUSTRIES, INC.

YUBA

Plants and Sales Offices NATIONWIDE

METHANOL

on stream
and on its way

With the recent completion of a new methanol plant in Florida, Chemico proved again that even the most complex chemical and petrochemical plants can be started up without delays and difficulties when they are designed and constructed by Chemico. As a result of Chemico's engineering efficiency, this Florida plant was on stream well ahead of schedule. A few short days after start-up, methanol produced in this new plant was actually in tank cars and on its way to customers.

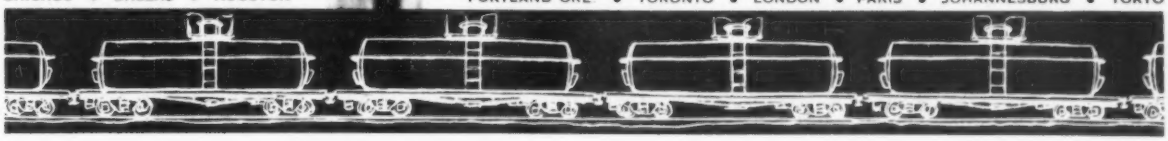
Whether you're planning a plant to produce methanol, ammonia, urea, sulfuric acid, nitric acid, acetylene, hydrogen or virtually any other basic industrial or agricultural chemical, you'll find that *Chemico Push-Button Processes* save time and money for Chemico clients.

Write today for the new general bulletin describing the wide range of Chemico's activities.

CHEMICO

CHEMICAL CONSTRUCTION CORPORATION
525 West 43rd Street, New York 36, New York

CHICAGO • DALLAS • HOUSTON PORTLAND ORE. • TORONTO • LONDON • PARIS • JOHANNESBURG • TOKYO

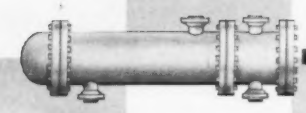


SERVICE: aromatics to aspirin

Benzene and Toluene currently produced at Cosden Petroleum Corporation's Big Spring, Texas refinery, so greatly exceed the purity requirements of the ASTM "Nitration Grade" specifications, that these products are now being used directly in the manufacture of pharmaceuticals such as aspirin and cortisone.

As integral parts of the UOP Rexforming® and Udex® units at Big Spring, Western heat exchangers perform an important service in the conservation and transfer of heat during the selective extraction of these aromatic hydrocarbons.

Heat Transfer requirements for petrochemical processes present a worthwhile challenge, and Western will continue to expand its sphere of influence in the petroleum industry's growing importance to chemical consumers.



WESTERN
HEAT EXCHANGERS
WESTERN SUPPLY COMPANY
P.O. Box 1888 – Tulsa, Oklahoma

The Mail Box . . .

A Real Contribution

To the Editor:

I have seen the two editorials that have appeared in recent issues of PETROLEUM REFINER ("It's Our Last Line of Defense," October, 1958 and "For Business, More than Soft Talk," December, 1958). It is heartening indeed to see this evidence that some editors at least have the perception to understand the major forces at work in this country and the courage to express themselves in print.

Your two editorials are factual, specific and deal with the political situation as it exists today with complete realism. One would think, after all the facts which have been placed on the public record concerning the activities and political operations of labor unions, that every editor in the country—newspaper, magazine, house organ, trade paper, etc.—would be up in arms and eager to give his readers the same kind of solid inspiration and leadership you are giving yours. Unfortunately, such is not the case and editors like yourself are few and far between.

You are making not only a significant editorial contribution to the industry which you serve but to the nation itself, and I hope you will be encouraged and heartened to proceed further to disseminate facts and truth.

Edward Maher,
Vice President
Public Relations Division
Nat'l. Assoc. of Manufacturers

New York, N. Y.

Good for Filing

To The Editor:

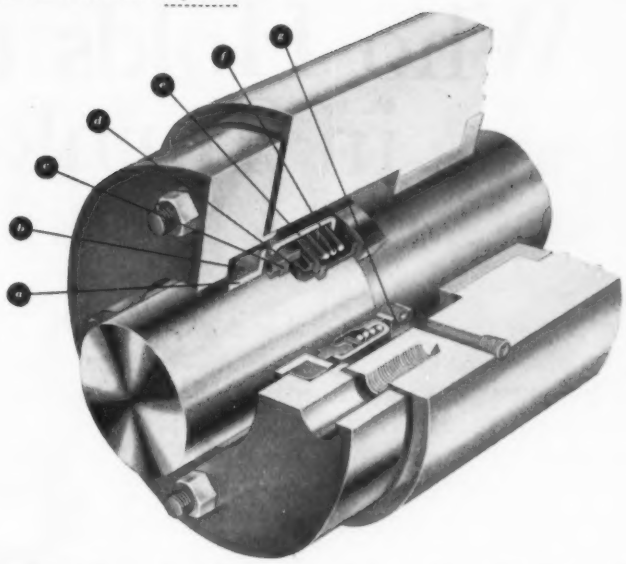
I was certainly pleased to see the special report about ejectors in the December issue of the PETROLEUM REFINER. I called it to the attention of our Process Design group who were already aware of it and plan to keep a copy in their file.

No doubt many others will use this information to good advantage, not only in industry but also students in petroleum engineering and other engineering fields.

M. Morrison
Technical Superintendent
Socony Mobil Oil Co., Inc.

August, Kansas

ONE OF THE GARLOCK **2,000**



GARLOCK Mechanical Seals —self-contained for easy installation, less downtime

a. ***Stationary Seat*** *of ceramic, Ni Resist, or bronze has precision lapped sealing face for perfect contact with carbon ring.*

b. ***Vibration Ring*** *of Buna-N positions stationary seat in a flexible mounting and acts as static seal.*

c. ***Seal Ring*** *of carbon is also precisely lapped to match sealing face of stationary seat.*

d. ***Roll type Bellows*** *permits free movement of seal ring.*

e. ***Shell,*** *encases entire rotary unit and furnishes mechanical drive for seal ring.*

f. ***Stainless Steel Spring*** *with load precisely calculated to face area of seal.*

g. ***Stop Collar,*** *or shoulder, positions seal to specified operating length.*

Garlock's PK MECHANIPAK* is designed to avoid excessive downtime. Self-contained, it can be installed simply and quickly, and eliminates adjustment during operation. Seal life is equal to many sets of conventional packings. Check these additional advantages:

Leak-proof sealing. Sealing faces of rotating and stationary parts are precision lapped for perfect contact, thus preventing leakage.

Elimination of shaft wear. No parts of the seal move on the shaft or sleeve, thus removing the danger of scoring or wear.

Maximum operating conditions are 212° F temperature, 150 psi pressure, 2000 fpm shaft speed. Available in shaft sizes from ⅜" to 3", PK MECHANIPAK Seals are another of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. Find out more by talking with your local Garlock representative, or write for Catalog AD-150.

*Registered Trade Mark

THE GARLOCK PACKING COMPANY, Palmyra, N.Y.

FOR PROMPT SERVICE, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

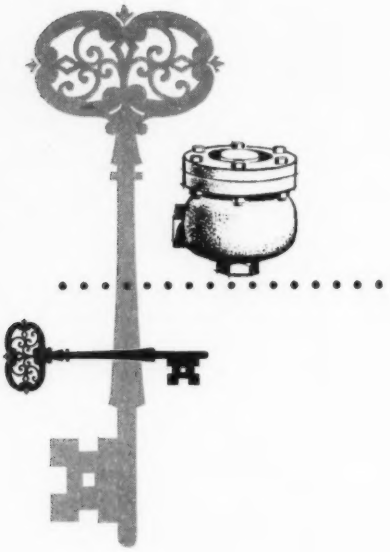
Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

CANADIAN DIVISION: The Garlock Packing Co. of Canada Ltd.
PLASTICS DIVISION: United States Gasket Company

For more data on advertised products, use Readers' Service Cards, last page.

A PETROLEUM REFINER SPECIAL REPORT

Who Holds the Key in Turnkey?



Not the consulting engineer.

Not the prime contractor.

Not the subcontractors.

Not even the customer's representative who, assigned to build a plant and stay within the building budget, is too often willing to forfeit the future for a good cost showing today.

The key to this plant's productivity and profits is held solely by the *owners*.

The owners must, of necessity, think in terms of how much this plant will produce, and at what cost. They must, of necessity, think of *total cost*.

Total cost includes the price of original equipment, the expense of installing it, and how much it costs to maintain it over the entire useful life of the plant.

Take steam traps, for example. Lots of traps cost less than Nicholson's. In a box on the jobber's shelf, that is.

But when the plant *owners* have paid the cost of installation, and "dry, clean steam" has been contaminated by everything from weld bead to broken beer bottles and the *owners* have paid the cost of that, and finally when the "bargain" traps have broken down in service—the *owners* call on Nicholson.

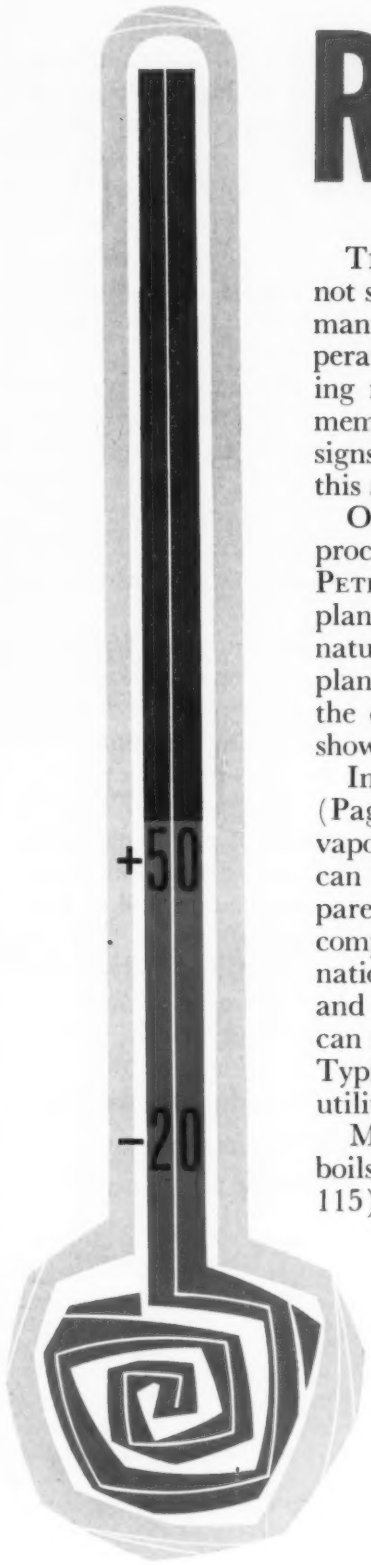
Quality Nicholson steam traps, sometimes higher in initial cost but always lower in installed cost, have long enjoyed the reputation of being the *owners'* favorite—the favorite of the people who, in the long run, have to pay the bill. ST-100

NICHOLSON

OF WILKES-BARRE

W. H. Nicholson and Co. • 14 Oregon Street • Wilkes-Barre, Pa.

Distributors in all principal cities



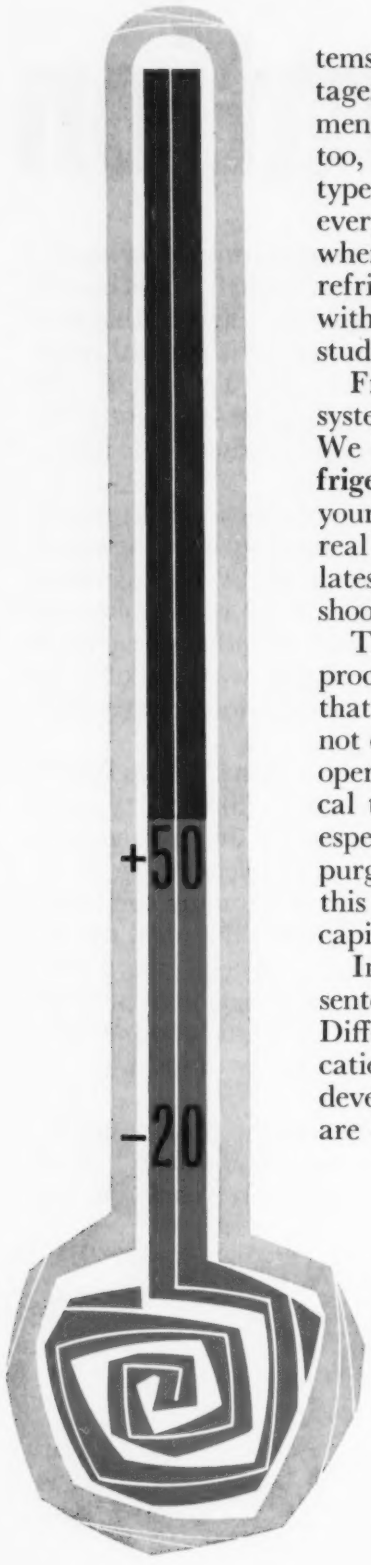
Refrigeration

THERE IS A DEFINITE TREND to low temperature processing—not so much the exotic — 300 F. range, although this is used in many phases of the industry, but the ordinary refrigeration temperatures of —20 to +50 F. This latter range is the real working range easily adapted to many processes. To refresh your memory and bring you up to date on the latest equipment designs for this range of low temperature processing is the aim of this special report.

One of the prime reasons for using refrigeration is to reduce processing costs and do a better job. This was brought out in PETROLEUM REFINER, January (1954) when two refrigeration plants were compared with a conventional absorption plant for natural gas liquids recovery. Not only did the refrigerated plants call for lower investment, their payout was quicker than the conventional plant. Also, vapor compression refrigeration showed lower costs of investment and operation.

In this Special Report, **"Which Refrigeration Cycle Is Best?"** (Page 111) gives an over-all comparison of different types of vapor compression refrigeration systems. So that refrigerants can be compared on an equal basis, all efficiencies are compared with the ideal Carnot cycle. Merely scanning the tables comparing different refrigerants quickly spots the ideal combination of refrigerant and conditions for your special case. Power and utilities required to make any refrigeration system perform can sometimes be overlooked in making economic comparisons. Typical cost comparisons are made where the importance of utilities is illustrated.

Many times when refrigeration is needed the prime question boils down to **"How to Select Refrigeration Equipment"** (page 115). A check list of the three major types of refrigeration sys-



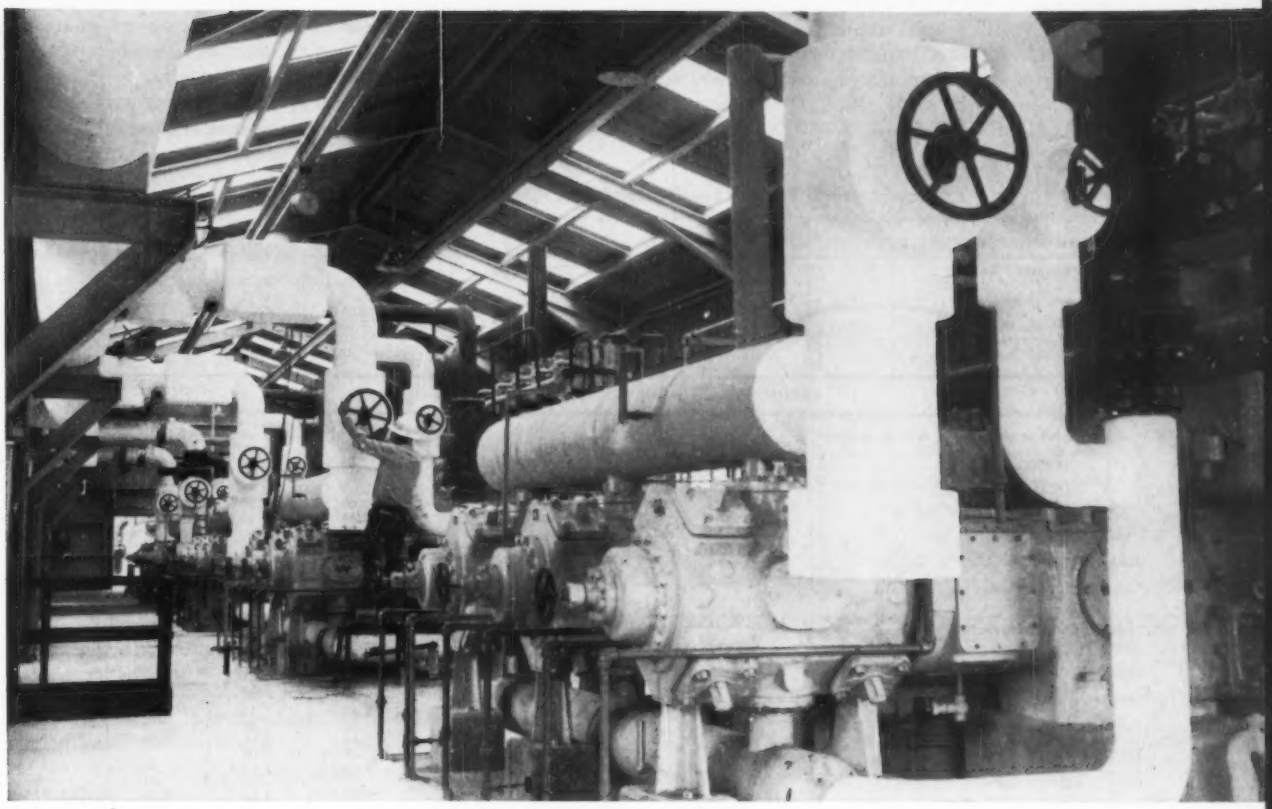
tems—vapor compression, absorption and jets—shows advantages and disadvantages along with power and utility requirements and offers early guidance in making a decision. Here, too, is a completely unbiased comparison for surely no single type of refrigeration system will solve all process needs. However, the article does point out the money savings to be had when using packaged, off-the-shelf, equipment in building a refrigeration system. Here, too, all efficiencies are compared with the ideal Carnot cycle for uniformity in making economic studies.

From our viewpoint, the most promising type of refrigeration system is vapor compression done with centrifugal compressors. We believe **"How to Operate and Maintain Centrifugal Refrigeration Machines"** (page 123) is needed to help answer your questions and solve some of your operating problems. Of real interest: Explanation of important construction features, latest developments in shaft seals and purge units, and a trouble-shooting check list.

The aim in using refrigeration is to get the most for your processing dollar. Vapor compression refrigeration does just that. For further savings, lean heavily toward packaged units, not only for lower capital expenditure but savings in space and operating costs. Purchased refrigerants seem to be more practical than use of some process stream for this purpose. This is especially true with the newer developments of shaft seals and purging equipment. Centrifugal compressors, ideally suited for this range of refrigeration, offer exceptional examples of low capitalization and freedom from maintenance.

In 1951, PETROLEUM REFINER (March, June, July) presented a series on "Refrigeration in the Refining Industry." Different refrigeration systems were described briefly, applications discussed and operating practices outlined. Subsequent developments in this field with a switch toward packaged units are contained in the current special report.

Thomas C. Ponder



Which Refrigeration Cycle Is Best?

Low investment and operation costs give the edge to vapor-compression refrigeration

Ruble L. Huff
Chem-Gas Engineers, Inc.
Houston

THE INCREASING requirements for higher plant efficiencies and the addition of new products in the refining, natural gasoline and petrochemical industry demand a complete engineering evaluation for the selection of new refrigeration equipment.

Vapor-compression and ammonia absorption refrigeration systems will be compared in this article showing typical investment and operating costs in the range of —20 F. to +50 F.

Mechanical refrigeration is classified in two general groups—vapor-compression and absorption systems —depending on the method used in recirculating the refrigerant.

Vapor-compression refrigeration systems include those processes where the refrigerant is evaporated, compressed, condensed and recirculated. In industrial practice, vapor-compression is the most important machine for the refrigeration principle, and in recent years developments have centered almost wholly around the vapor-compression system.

Absorption systems differ from vapor-compression refrigeration in

requiring no positive work input to produce cold, although some external accessory power (ammonia liquid pump and ammonia still reboiler heat) is required. Circulation is effected by absorption of the refrigerant in the appropriate liquid that is regenerated by heat in another part of the refrigerating system. The industrial application of the absorption machines are where large quantities of waste heat are available.

Theory. The process of pumping heat from a low temperature to a higher

TABLE 1—Refrigerant Characteristics[5]

EVAPORATOR TEMPERATURE F.	—20	—10	0	10	20	30	40	50
Evaporator Pressure Psia.								
Ammonia	18.30	23.74	30.42	38.51	48.21	59.74	73.32	89.19
Propane	25.05	30.95	37.81	45.85	55.00	65.77	77.80	91.50
Iso-butane	7.5	9.28	11.6	14.6	18.2	22.3	26.9	32.5
Trichlorofluoromethane	1.42	1.92	2.56	3.34	4.34	5.56	7.03	8.8
Dichlorodifluoromethane	15.28	19.2	23.87	29.35	35.75	43.16	51.68	61.39
Chlorodifluoromethane	25.01	31.29	38.79	47.63	57.98	69.93	83.72	99.4
CONDENSED LIQUID TEMPERATURE, 85 F. AND 105 F.								
CFM of Refrigerant per ton of Refrigeration								
Ammonia 85 F.	6.30	4.88	3.85	3.06	2.47	2.00	1.64	1.35
105 F.	**6.6**	**5.15**	**4.05**	**3.22**	**2.58**	**2.10**	**1.72**	**1.42**
Propane	6.97	5.56	4.45	3.65	3.03	2.46	2.01	1.69
	7.85	**6.25**	**5.01**	**4.10**	**3.37**	**2.73**	**2.22**	**1.87**
Iso-butane	20.62	16.42	12.98	10.12	8.06	6.49	5.28	4.32
	24.02	**19.09**	**15.03**	**11.69**	**9.26**	**7.42**	**6.01**	**4.91**
*Trichlorofluoromethane	74.3	55.1	41.3	31.5	24.5	18.9	15.1	12.0
	79.8	**59.0**	**44.3**	**33.8**	**26.1**	**20.2**	**16.1**	**12.8**
Dichlorodifluoromethane	10.3	8.05	6.4	5.17	4.18	3.43	2.82	2.36
	11.4	**8.95**	**7.12**	**5.75**	**4.65**	**3.81**	**3.14**	**2.62**
Chlorodifluoromethane	6.2	4.92	3.96	3.21	2.61	2.15	1.78	1.48
	6.87	**5.47**	**4.4**	**3.56**	**2.9**	**2.38**	**1.97**	**1.64**
BHP per Ton of Refrigeration								
Ammonia 85 F.	1.772	1.545	1.328	1.123	.937	.752	.609	.453
105 F.	**2.194**	**1.936**	**1.698**	**1.463**	**1.308**	**1.061**	**.886**	**.731**
Propane	2.07	1.77	1.510	1.252	1.406	.849	.665	.510
	2.67	**2.110**	**1.980**	**1.715**	**1.470**	**1.240**	**1.020**	**.828**
Iso-butane	2.130	1.870	1.610	1.355	1.105	.882	.720	.559
	2.87	**2.560**	**2.255**	**1.95**	**1.650**	**1.350**	**1.097**	**.900**
Trichlorofluoromethane	1.75	1.56	1.38	1.2	1.02	.86	.74	.63
	2.2	**2.0**	**1.78**	**1.54**	**1.32**	**1.11**	**.94**	**.80**
Dichlorodifluoromethane	2.1	1.78	1.51	1.275	1.07	.89	.75	.625
	2.72	**2.24**	**1.89**	**1.61**	**1.36**	**1.15**	**.965**	**.81**
Chlorodifluoromethane	2.01	1.655	1.395	1.165	.970	.820	.673	.560
	2.44	**2.09**	**1.79**	**1.53**	**1.29**	**1.10**	**9.25**	**.785**
Coefficient of Performance (COP)								
Carnot Cycle 85 F.	4.20	4.73	5.40	6.25	7.38	8.90	11.10	14.60
105 F.	**3.52**	**3.91**	**4.38**	**4.95**	**5.64**	**6.52**	**7.68**	**9.28**
Ammonia	2.65	3.05	3.55	4.18	5.03	6.27	7.75	10.4
	2.15	**2.44**	**2.79**	**3.22**	**3.61**	**4.43**	**5.31**	**6.44**
Propane	2.28	2.66	3.12	3.76	4.52	5.55	7.1	9.25
	1.76	**2.23**	**2.38**	**2.75**	**3.21**	**3.8**	**4.62**	**5.68**
Iso-butane	2.21	2.52	2.93	3.48	4.27	5.35	6.55	8.45
	1.64	**1.84**	**2.09**	**2.42**	**2.86**	**3.49**	**4.30**	**5.24**
Trichlorofluoromethane	2.7	3.02	3.42	3.94	4.62	5.48	6.38	7.50
	2.15	**2.36**	**2.65**	**3.07**	**3.58**	**4.25**	**5.02**	**5.9**
Dichlorodifluoromethane	2.25	2.65	3.12	3.7	4.41	5.3	6.28	7.53
	1.73	**2.10**	**2.49**	**2.92**	**3.47**	**4.10**	**4.88**	**5.82**
Chlorodifluoromethane	2.35	2.85	3.38	4.05	4.85	5.75	7.0	8.41
	1.93	**2.25**	**2.63**	**3.08**	**3.65**	**4.28**	**5.1**	**6.0**
Percent of Carnot Efficiency								
Carnot Cycle	100.	.....	.....	.....	.....	.....	.....	.....
Ammonia 85 F.	63.1	64.5	65.5	66.9	68.1	70.5	69.7	71.2
105 F.	**61.0**	**62.5**	**63.5**	**65.0**	**64.0**	**68.0**	**69.0**	**69.4**
Propane	53.3	56.2	57.7	60.1	61.2	62.3	64.0	63.3
	50.0	**57.0**	**54.2**	**55.5**	**57.0**	**58.2**	**60.0**	**61.3**
Iso-butane	52.5	53.2	54.2	55.6	57.8	60.2	59.0	57.8
	46.7	**42.1**	**47.7**	**48.9**	**50.7**	**53.5**	**55.8**	**56.5**
Trichlorofluoromethane	64.2	63.8	63.3	63.0	62.5	.....	57.5	.....
	61.0	**60.5**	**60.5**	**62.0**	**63.5**	**65.1**	**65.3**	**63.6**
Dichlorodifluoromethane	53.5	56.0	57.7	59.2	59.7	59.5	56.5	51.5
	49.2	**53.7**	**56.7**	**59.0**	**61.5**	**62.8**	**63.5**	**62.7**
Chlorodifluoromethane	56.0	60.2	62.5	64.8	65.6	64.7	63.0	57.5
	54.8	**57.5**	**60.0**	**62.2**	**64.7**	**65.7**	**66.3**	**64.**

CONDENSER PRESSURE, PSIA.

Condensed Liquid Temperature	85 F	105 F
Ammonia	166.4	228.9
Propane	154.0	201.5
Iso-butane	58.6	79.3
Trichlorofluoromethane	17.9	25.8
Dichlorodifluoromethane	106.3	140.9
Chlorodifluoromethane	171.9	227.6

* This refrigerant is normally used in centrifugal compressors.

TABLE 2—Ammonia Absorption Refrigeration

EVAPORATOR TEMPERATURE F.	—20	—10	0	10	20	30	40	50
Coefficient of Performance	0.17	0.20	0.20	0.21	0.21	0.22	0.23	0.23
Percent of Carnot Efficiency	4.83	5.12	4.57	4.24	3.72	3.37	2.99	2.48

temperature is called refrigeration and requires the expenditure of energy on the system from some external source. The Carnot cycle is the ideal cycle for the production of work from heat. In the refrigeration cycle, the advantages of a vapor for a refrigerant instead of a gas to approach the ideal Carnot cycle is well known.[1,2,3,4]

Refrigerant Characteristics. Table 1 shows the most important physical characteristics for six of the most popular refrigerants. The CFM of refrigerant per ton of refrigeration is at actual temperature and pressure conditions at compressor inlet. The brake horsepower per ton was calculated assuming an over-all compressor efficiency of 75 percent. The coefficient of performance (COP) and the percent efficiency of the refrigeration system as compared to the Carnot cycle is also tabulated.

All of the above characteristics were calculated at 85 F. and 105 F. refrigerant condenser temperature levels. The two refrigerant temperatures were chosen to show the difference in refrigeration system efficiencies for a specific location with known temperature limits for condensing the refrigerant.

However, the assumption of an over-all efficiency of 75 percent at both refrigerant temperatures does not give a true analysis for the calculated bhp per ton. The over-all efficiency depends on the characteristics of the compressor and refrigerant characteristics such as molecular weight, specific heat of liquid and vapor, compression ratio, latent heat of vaporization and critical pressure. In general, the over-all compressor efficiency rapidly decreases as the refrigerant condensing temperature increases which in turn increases the bhp per ton of refrigeration required.

Table 2 was prepared as a comparison with vapor-compression refrigeration. The COP for absorption refrigeration was calculated from the equation:[6]

$$\text{COP} = \frac{\text{Evaporator Capacity, Btu hr.}}{\text{Fuel Input, Btu hr.}}$$

The requirements for fuel input were taken from Figure 1.[7] The percent Carnot efficiency was calculated using the Carnot COP at 105 F. condenser refrigerant temperature level from Table 1.

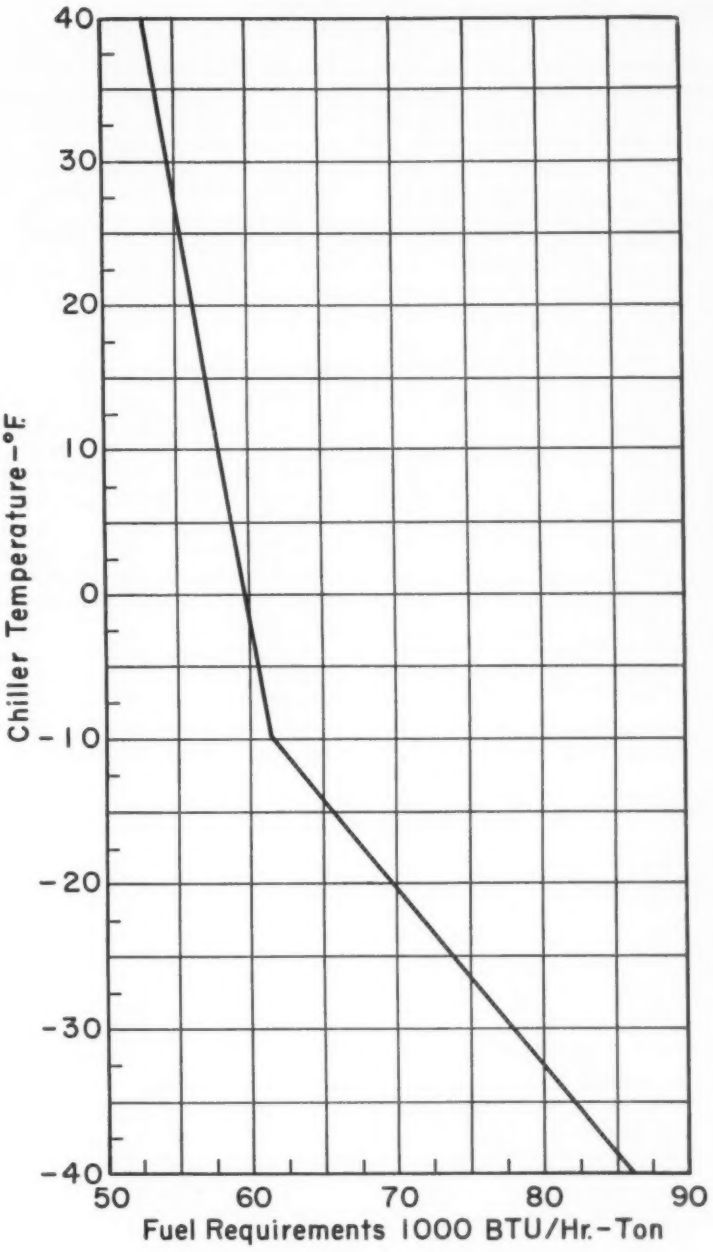


FIGURE 1—High fuel requirements for ammonia absorption refrigeration systems are in part responsible for their low efficiency.[7]

Investment Costs. Table 3 gives estimated investment costs for complete installations with all accessories except the gas chiller for reciprocating and centrifugal compressors and ammonia absorption refrigeration units. The cost per ton does not decrease uniformly as capacity increases for reciprocating machines shown due to the number of units used in the 350-ton capacity. However, these investment costs were used since they were available. The bhp per ton does not fit Table 1 ($2.09 \times 85 = 178$ bhp) due to the selection of two gas engine drivers in nearest size (240 bhp) to fit the required 178 bhp.

Utilities requirements are also tabulated in Table 3. The cooling water

requirements can readily be compared for the different systems. Ammonia absorption requires about 2.2 times as much cooling water as the centrifugal system at the 85-ton capacity. Also the absorption system uses about 2.6 times as much fuel as the centrifugal system. At the 350-ton capacity, the ammonia absorption unit uses 315 Mscfd more fuel than the centrifugal unit. Assuming a Gulf Coast price for gas of 13.5 cents per Mcf, the additional 315 Mscfd is worth $42.50 per day or $15,512.50 per year.

TABLE 3—Investment Costs & Utilities

CAPACITY, TONS	85	350
Reciprocating Compressor		
Refrigerant	Chlorodifluoro-methane	Ammonia
Refrigerant Temp. F	—10	—10
No. of units	2	6
Total Bhp driver	240	730
GPM 85 F water	400 (10 F rise)	1900 (6 F rise)
Fuel Mscf, driver	69	210
Cost per ton	$350	$345
Total cost	$29,750	$120,750
Centrifugal Compressor		
Refrigerant	Trichlorofluoro-methane	Dichlorodifluoro-methane
Refrigerant Temp. F	—10	—10
Total Bhp driver	165	700
GPM 85 F water	270 (10 F rise)	1220 (10 F rise)
Fuel Mscf, driver	48	202
Cost per ton	$380	$330
Total Cost	$32,300	$115,500
Absorption Refrigeration		
Refrigerant	Ammonia	Ammonia
Refrigerant Temp. F	—10	—10
Fuel Mscf, Reg.reboiler	125	517
GPM 85 F Water	595	2,450
Cost per ton	$700	$400
Total cost	$59,500	$140,000

Note: All fuel gas volumes based on 1,000 Btu/cf and 12 cf/bhp.

TABLE 4

	Water	Air Condensing
Capacity, Tons	60	60
Refrigerant	Trichloromono-fluoromethane	Trichloromono-fluoromethane
Refrigerant Temp. F	—10	—10
No. of Units	1	1
GPM 87 F. Water	200 (10°F Rise)	.....
Total BHP Driver	120	160
Fuel MSCF, Driver	29	38
Electric Utilities		
Fan Motors on Condenser	.....	2—3 HP
Purge Unit	¾ HP	¾ HP
Condenser Water Pump	10 HP	.....
Fan on Cooling Tower	3 HP	.....
Cost Per Ton	$575	$625
Total Cost	$34,500	$37,500

About the Author

R. L. Huff is vice president of Chem-Gas Engineers, Inc., Houston, where he also serves as general manager in charge of engineering, design and construction. He has a B.S. degree in chemical engineering from Louisiana State University, and has been chief process engineer for Pona Engineers, Inc., chief engineer for Texas Gas Corp., and a process engineer for Phillips Chemical Co. Huff is a registered professional engineer in Texas.

The Future. Years ago the reciprocating compressor was the important tool for vapor-compression refrigeration. Originally, lubrication and maintenance problems were encountered. However, recent developments in the reciprocating machine have improved these problems, and in many instances these machines are efficiently operating as package units with very little attention.

The centrifugal compressor came into being as a high volume low compression ratio unit. Recent developments in the centrifugal have adapted this unit to small volumes and yet made it competitive in cost. About the only disadvantage in the centrifugal compressor is the large number of stages required for a high compression ratio. However, the large number of stages could be an advantage if two level refrigeration is required thereby reducing the total bhp required. Also the centrifugal is nonlubricated and its low maintenance cost and operating flexibility make it the most efficient vapor-compression system now available.

New developments claim a positive displacement axial flow rotary compressor with a compression ratio of 5.0 to 1.0 in one stage and 11.0 to 1.0 in two stages with external intercooling. Somewhat higher efficiencies are claimed, and the unit is supposed to be adaptable to small volumes and at the same time the compressor has characteristics that will handle a wide range of refrigerants. This compressor will be ready for industrial trial this year.

Aid Cooled Condensing. Due to the condensing medium available at certain locations for the refrigerant, it is sometimes desirable to use air cooled condensers. Table 4 shows a comparison of a 60 ton package centrifugal refrigeration unit using water and air condensing. The cost figures include centrifugal compressor with gas engine driver, gas chiller (1000 psig on process side), refrigerant condenser, refrigerant piping, refrigerant controls and cooling tower.

An ammonia refrigeration unit was not priced on air condensing since the pressure rating required is above the manufacturer's normal stock equipment. The ammonia air condensing unit requires a condenser pressure of 307.8 psia for 125 F refrigerant condensing temperature, 2.53 bhp per ton, and has a COP actual of 2.48 with a 74.5 percent efficiency as compared to the Carnot Cycle. The ammonia air condensing system as compared to the water condensing has a 45.3 percent increase in bhp per ton for duplicated conditions shown in Table 4.

The trichloromonofluoromethane unit requires a condenser pressure of 36.08 psia for the 125 F refrigerant condensing temperature, 2.60 bhp per ton, and has a COP actual of 2.47 with a 74.2 percent efficiency as compared to the Carnot Cycle. The trichloromonofluoromethane air condensing system as compared to the water condensing (Table 4) has 33.3 percent increase in bhp per ton. It should be noted that ammonia and trichloromonofluoromethane have almost identical physical properties as a refrigerant as compared in the air condensing system with a 125 F refrigerant temperature.

Conclusion. The author has tried to point out the need for a complete evaluation of refrigerant condensing temperature limits, proper selection of a refrigerant and the most efficient system to achieve the desired refrigeration load. Generally, stock item equipment does not take all of these facts into consideration.

LITERATURE CITED

[1] Chemical Engineering Thermodynamics, B. F. Dodge, McGraw-Hill Book Co., Inc., New York City, (1944), Page 430.

[2] Chemical Process Principles, Part II, O. A. Hougen & K. M. Watson, John Wiley & Sons, Inc., New York City (1954), Page 575.

[3] Elementary Engineering Thermodynamics, V. W. & C. A. Young, McGraw-Hill Book Co., Inc., New York City (1941), Page 185.

[4] Chemical Engineers Handbook, McGraw-Hill Book Co., Inc., New York City (1950), Page 1676.

[5] Engineering Data Book, Natural Gasoline Supply Mens' Association, Seventh Edition (1957). Trichlorofluoromethane, Dichlorodifluoromethane and Chlorodifluoromethane prepared from tables.

[6] An Improved Absorption Refrigeration Cycle, E. P. Whitlow and J. S. Swearingen, Page 13, Presented at South Texas Section, AIChE, Galveston, Texas, Oct. 3, 1958.

[7] Ammonia Absorption Refrigeration Selected for Gasoline Plant, The Refining Engineer, July 1957, p. C-25.

How to Select Refrigeration Equipment

Here's a practical guide for the designer in evaluating and selecting process chilling equipment

James T. Robertson
Carrier Corporation
Houston

MECHANICAL REFRIGERATION in the petroleum, petrochemical or chemical industries can increase production, improve product quality, or recover valuable material from the stream for re-use. Before the cooling system best suited to the specific job can be designed, however, there are a number of variables which must be resolved. They are—

1. Refrigeration load in Btu/hour, or more commonly used term, tons* of refrigeration.

2. Temperature level to which the process fluid or "stream" must be chilled.

3. Available source of energy for driving the refrigeration compressor: electricity for motors; steam or high pressure gases for turbines, absorption type chillers, or combustion fuel for

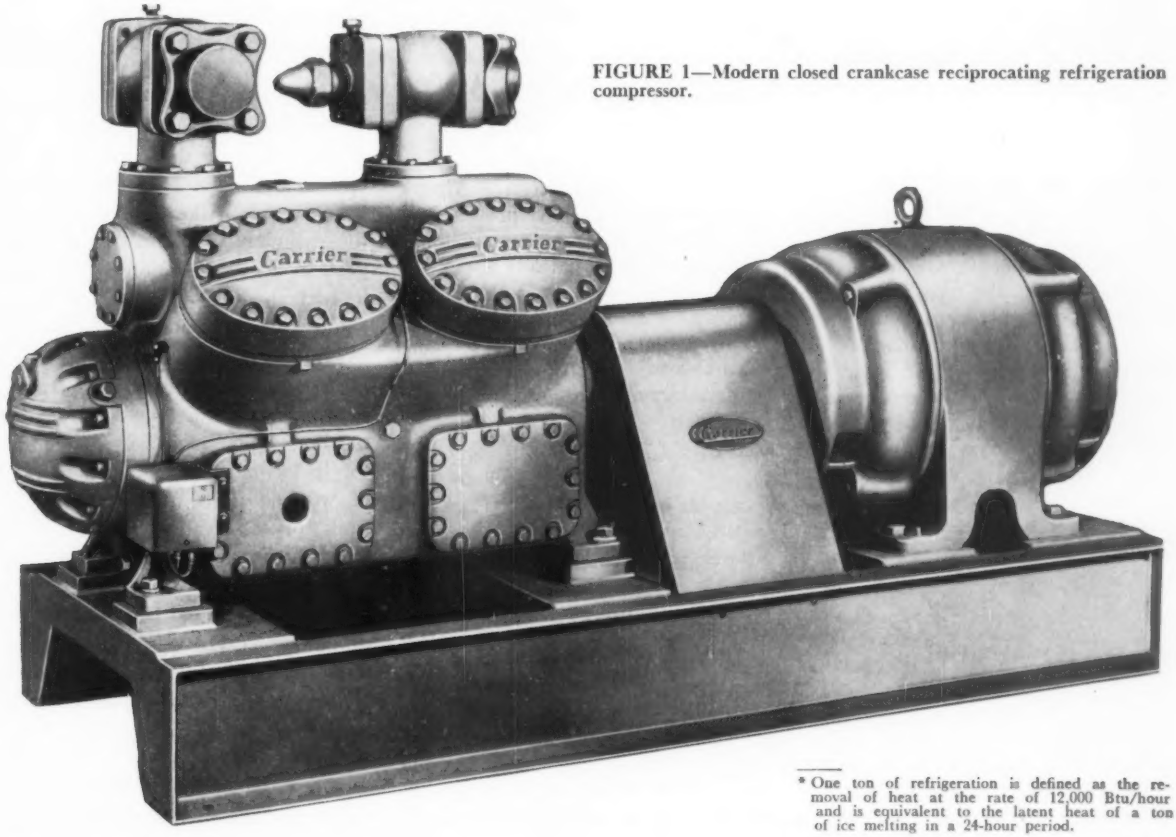


FIGURE 1—Modern closed crankcase reciprocating refrigeration compressor.

* One ton of refrigeration is defined as the removal of heat at the rate of 12,000 Btu/hour and is equivalent to the latent heat of a ton of ice melting in a 24-hour period.

gas or diesel engines.

4. Temperature, quantity, quality and availability of water for condensing refrigerant. If water is not available, air cooled condensing can be used for most mechanical compression systems.

5. Space available for installing equipment. In a new plant, floor area may not be a problem, but since costs are related to space, it is desirable to keep this at a minimum. In existing operations, this could well be the factor determining the type of refrigeration equipment used.

These engineering tangibles are the basis for determining the size, and sometimes the type of refrigeration plant required. On occasions, more than one type may be technically suited. It is therefore necessary to make a selection of equipment from a practical consideration of:

(a) Sizes or capacity available
(b) Operating flexibility
(c) Maintenance expense
(d) Long life reliability
(e) Automatic operation
(f) Installed cost

Here is a brief description of each of the four principle refrigeration systems. The most common have names describing their particular method of operation. Reciprocating and centrifugal equipment use the mechanical compression system. Absorption and steam jet apparatus use thermal compression systems.

RECIPROCATING UNITS

Historically, mechanical refrigeration was the only type available for large scale refrigeration projects. Later developments have proven more practical for supplying large volumes. Today, refrigeration loads under 100 tons cooling capacity are generally handled by reciprocating machines because they provide the lowest capital expenditure. Single units are made, however, with up to 200 tons capacity.

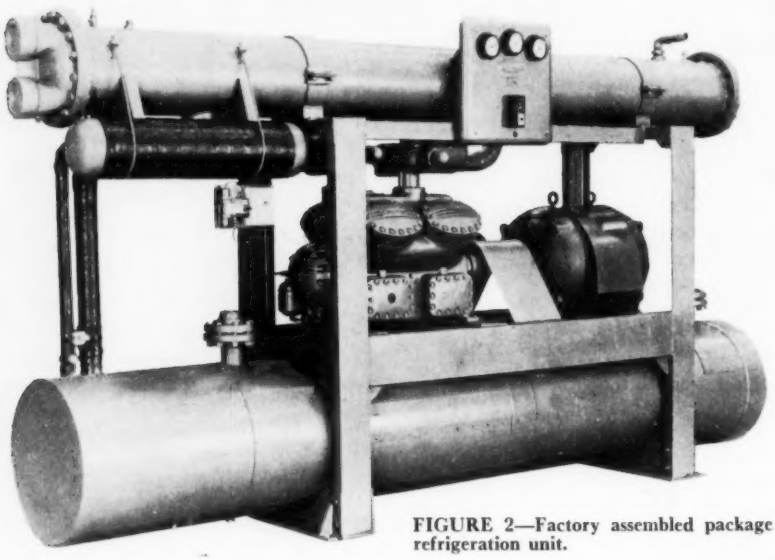


FIGURE 2—Factory assembled package refrigeration unit.

Heart of the machine is a reciprocating compressor. There are two types of compressors which are selected according to the duty on which the machine will be used. The basic difference is in the crankcase design. In units built for customary refrigeration service, a closed crankcase is used. By this is meant, the crankcase is open to the cylinder, but closed to the atmosphere, so there is no leakage of air into the machine on vacuum duty, or leakage of refrigerant from the machine when the suction pressure is above atmospheric pressure. In this type of machine, mechanical seals are normally provided where the crankshaft passes through the compressor body. Also, great effort is expended in piston sealing to prevent oil from being carried out of the compressor into the refrigeration system. Should this occur, it seriously minimizes effectiveness of transfer. Also, replacement of oil lost in this way, can create an expensive operating cost picture. On the older, slow-speed machine the cylinders are generally arranged in the vertical position. More modern reciprocating compressors have their cylinders set vertically or in a "V" depending on the number used. This type of machine is shown in Figure 1.

In the open type machine used for compression cooling of the process gas stream, the cylinder is sealed from the atmosphere where the connecting rod passes through the compressor body by a stuffing box. In this type of compressor, it is important that the suction pressure be kept above atmospheric pressure to prevent large amounts of air from entering the system and raising the discharge pressure above the design. If air leaks in, this shows up in the refrigerant condenser as non-condensible gases with a very serious effect on the capacity of the machine and the horsepower of the prime mover. Also, lubricating oil to the cylinders is pumped into other parts of the refrigeration system, with its detrimental effect on heat exchange surfaces and loss of oil.

It is generally recognized that maintenance labor, parts and operating expenses are higher for reciprocating machines than other systems. This is due principally to a greater number of wearing parts, such as bearings, rings, pistons against cylinder walls, seals, plus suction and discharge valves.

Slugs of liquid refrigerant from the process heat exchangers can also damage valves, pistons, crankshafts and connecting rods. Suction line piping and knock-out drums properly designed as well as safety devices can minimize danger of this happening.

The trend in reciprocating refriger-

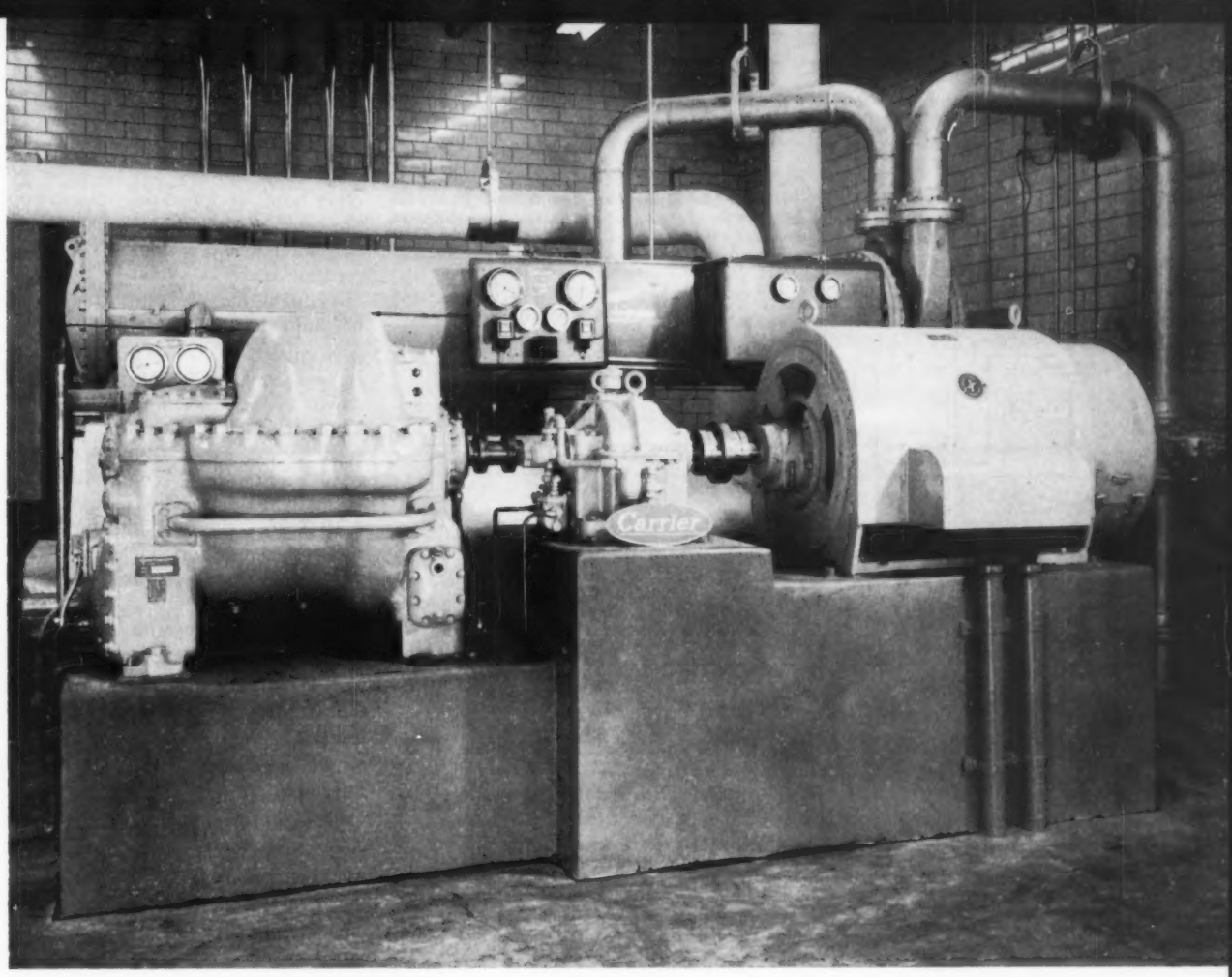


FIGURE 3—Packaged centrifugal refrigeration unit with electric motor drive.

ation equipment is to build the system into a complete package consisting of compressors, heat exchangers, interconnecting refrigerant piping and safety controls all assembled on a steel framework at the factory (Figure 2). Instead of fitting parts together at the job site, the machine is merely set in place and after connected to the required utilities, is ready to operate. These package machines are available in sizes ranging from about 2 hp through 150 hp. This package type of unit has substantially reduced the cost of installing refrigeration equipment.

CENTRIFUGAL REFRIGERATION

Like reciprocating units, there are two types of centrifugal compressors available for refrigeration duty. One uses a family of fluorinated hydrocarbons as the refrigerant; for the other —hydrocarbons such as propane and butane are used. The former machines operate at low pressure and are hydraulically designed to handle heavy molecular weight gases (i.e., dichlorodifluoromethane has a molecular weight of 120). Centrifugal compressors are also designed for all types of gas compression ranging from hydrogen with light molecular weight to

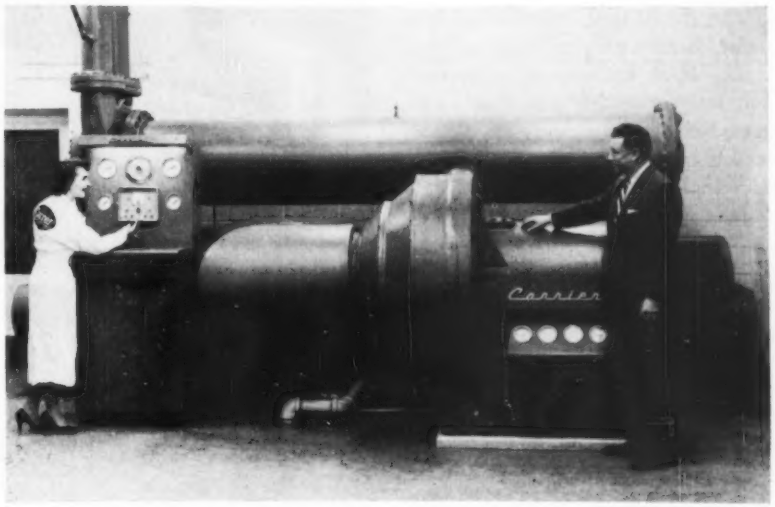


FIGURE 4—Hermetic centrifugal compressor refrigeration unit.

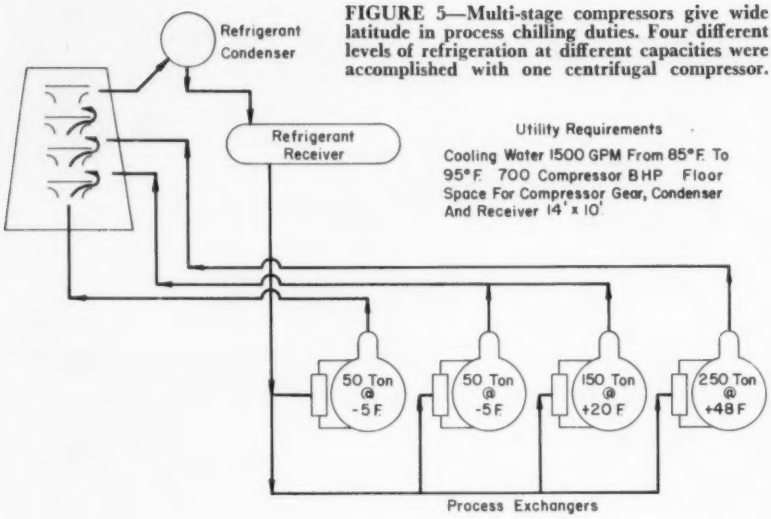

Refrigerant Condenser
Refrigerant Receiver
Utility Requirements
Cooling Water 1500 GPM From 85°F To 95°F 700 Compressor BHP Floor Space For Compressor Gear, Condenser And Receiver 14' x 10'
50 Ton @ -5F
50 Ton @ -5F
150 Ton @ +20F
250 Ton @ +48F
Process Exchangers

FIGURE 5—Multi-stage compressors give wide latitude in process chilling duties. Four different levels of refrigeration at different capacities were accomplished with one centrifugal compressor.

the "heavyweight," chlorine. For this duty, casings capable of withstanding pressures up to 2,000 Psig have been made. Incorporating all types of alloys and seals, the majority have been applied to propane and butane cooling.

From a refrigeration standpoint, the two types complement one another. The fluorinated hydrocarbon machines have capacities ranging from approximately 100 tons to 4,000 tons, and the propane machine from 1,000 tons up. In several instances however, fluorinated hydrocarbon centrifugals have been used on refrigeration loads as low as 40 tons, and butane compressors on capacities as small as 300 tons.

The fluorinated hydrocarbon unit today, is essentially a "package" machine. Heat exchangers, compressor and interconnecting piping are integrated components ready for easy assembly of the parts, too large to ship as a single unit (Figure 3).

In the last five years the "package" concept has been further accented by economies attainable in the hermetic centrifugal. Here the electric motor driver is enclosed within the compressor structure, eliminating gears and shaft seals. The hermetic has limited suitability for temperatures outside of the typical air conditioning chilled water range of 40 to 50 F. Within the 10 degree spread, it has economic advantages that make it the biggest selling centrifugal "package" (Figure 4).

The centrifugal refrigeration machine is individually distinctive, compressing refrigerant through narrow passageways by a series of rotors spinning at high speeds. When higher compression ratios are needed, they are obtained by including more stages, or wheels. In reciprocating machines each compressor is usually single stage compression. Higher compression ratios are obtained by adding more reciprocating machines in series. On the other hand, reciprocating compressors are positive displacement devices and therefore, where a single-stage reciprocating machine would be used, the centrifugal for the same job would be multi-stage.

Normally, a two-stage compressor is used for refrigerant temperatures down to approximately +25 F. Three-stage compressors are normally used in the range from +25 F to —10 F. Four-stage compressors are normally used in the range from —10 F to —60 F. While for reciprocating compressors single stage compression is normally used down to temperatures of —10 F to —20 F; two-stage compression is normally used down to temperatures of —50 F to —60 F; and three-stage compression to lower temperatures. The compression ratio is usually the guide as to the number of stages of compression used.

The use of multi-stage compressors gives the designer an opportunity to use economizers by which the liquid refrigerant is flash cooled to the interstage pressure levels, thereby reducing the total weight flow through the compressor and appreciably reducing the total power requirements to do a given job. The use of a multi-stage compressor also lends itself readily to

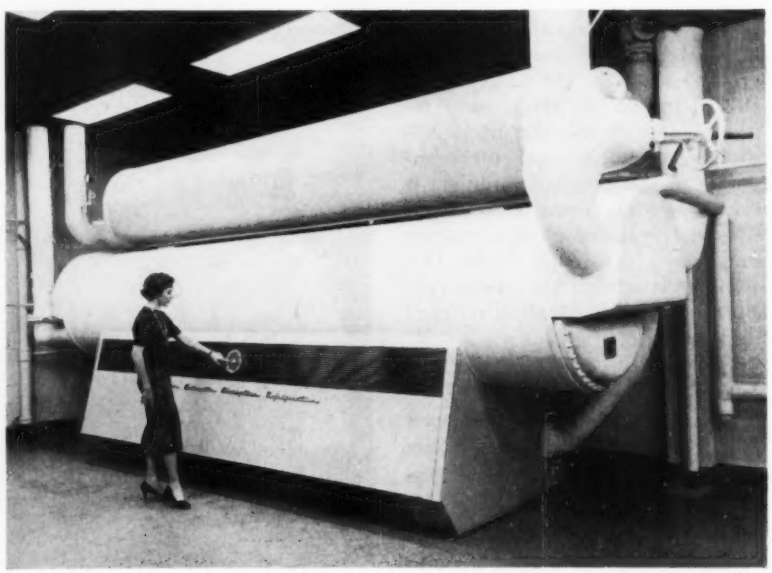


FIGURE 6—Modern water-lithium bromide absorption refrigeration unit.

handling refrigerant gas streams from separate exchangers at different temperature levels. Figure 5 illustrates an example of what can be done. The load in this case is 250 tons at +40 F, 150 tons at +20 F, and two 50 ton exchangers at —5 F.

A separate machine could have been put on each load, or a single machine could have been installed, doing a total load of 500 tons at —5 F. The first plan would have been very expensive; the second (even with a flash economizer) would have required a total of 950 hp, 2,000 gpm of cooling water and a more expensive compressor. The method settled on reduced the power requirements to 700 hp, the water requirements to 1,500 gpm, and the compressor and installation costs were a minimum. A single stage reciprocating system would have required approximately 1,100 hp to do the job.

A centrifugal compressor has few wearing parts, in fact, only two sleeve-type shaft journals. The journals are precision fitted and do not require scraping and fitting in the field before they are installed. The simple automatic shaft seals used have unlimited life. Hundreds of machines on process refrigeration duty have operated with original seals for 15 to 20 years.

Oil loss in today's centrifugals is not a problem, hence heat exchanger

TABLE 1—Characteristics of Common Refrigerants

	Gauge pressure corresponding to saturated suction temperature	Gauge pressure corresponding to saturated condensing temperature	Specific volume of vapor at saturated suction temperature	Latent heat of evaporation	Liquid circulation: Pounds/Minute/Ton	Theoretical displacement: Cubic feet/Minute/Ton	Refrigerating effect: Btu/Pound	Pressure ratio: Condenser pressure in lb. absolute / Suction pressure in lb. absolute	Theoretical hp/ton	Coefficient of performance = 200 / (Theoretical hp x 42.4)	Efficiency % Carnot cycle
Suction at 5 F Saturated Condensing at 86 F Saturated											
Ammonia	19.6	154.5	8.15	565.0	0.42	3.44	474.4	4.93	.989	4.77	83.2
Dichlorodifluoromethane	11.8	93.2	1.49	69.47	3.92	5.82	51.1	4.07	1.00	4.69	82.1
Chlorodifluoromethane	28.33	159.8	1.246	93.59	2.89	3.692	69.28	4.05	1.018	4.63	81.0
Methyl Chloride	6.46	80.0	4.47	180.70	1.33	5.95	150.25	4.48	.963	4.90	85.9
1,1,2-trichloro-1, 2, 2-trifluoroethane	27.92" vacuum	13.93" vacuum	27.04	70.62	3.73	100.7	53.67	8.01	0.965	4.88	85.2
sym-dichlorotetrafluoroethane	16.14	21.99	4.221	61.98	4.64	19.60	43.10	5.42	1.018	4.64	81.1
Carbon Dioxide	317.5	1028.3	0.266	117.5	3.60	.958	55.5	3.14	1.94	2.4	42
Methylene Chloride	27.55" vacuum	8.35" vacuum	49.90	162.10	1.49	74.5	134.1	8.59	.965	4.89	85.2
Trichlorofluoromethane	23.95" vacuum	3.58	12.27	84.00	2.96	36.4	67.5	6.24	.936	5.04	88.2
Azeotrope of dichlorodifluoromethane and unsym-difluoroethane	16.32	113.42	1.5231	84.215	3.27	4.98	61.19	4.14	1.015	4.65	81.5
Propane	26.98	141.5	2.52	171.35	1.625	4.1	123.0	3.75	1.03	4.59	80.0
Butane	——	26.9	9.98	169.5	1.622	16.2	125.5	5.09	.982	4.81	84.0
Carnot Cycle	——	——	——	——	——	——	——	——	.822	5.74	100.0
Suction at 40 F Saturated Condensing at 100 F Saturated											
Ammonia	58.6	197.2	3.97	536.2	0.43	1.70	467.8	2.89	.649	7.28	87.3
Dichlorodifluoromethane	36.98	116.9	0.792	65.7	3.88	3.07	51.6	2.54	.667	7.07	84.9
Chlorodifluoromethane	69.02	197.9	0.656	87.39	2.94	1.926	68.11	2.54	.689	6.85	83.7
1, 1,2-trichloro-1, 2, 2-trifluoroethane	24.52" vacuum	8.59" vacuum	10.68	68.5	3.59	38.3	55.66	3.95	.630	7.48	90.0
sym-dichlorotetrafluoroethane	0.52	31.69	1.982	58.86	4.47	8.86	44.67	3.04	.668	7.06	84.8
Trichlorofluoromethane	15.61" vacuum	8.90	5.45	81.2	2.90	15.82	68.8	3.36	.625	7.55	90.6
Azeotrope of dichlorodifluoromethane and unsym-difluoroethane	46.17	141.9	0.8018	78.99	3.26	2.61	61.36	2.58	.675	6.98	83.8
Water	29.75" vacuum	28.07" vacuum	2438.0	1068.8	0.198	483.0	1011.3	7.78	.69	6.85	82.1
Carbon Dioxide*	553.1	1054.7	0.1444	95.0	5.04	0.727	39.7	1.885	1.105	4.671	44.65
Propane	63.10	174.0	1.33	159.6	1.63	2.17	122.4	2.405	.678	6.98	83.8
Butane	3.0	37.5	4.88	163.5	1.563	7.64	128.0	2.95	.687	6.89	82.8
Carnot Cycle	——	——	——	——	——	——	——	——	.566	8.34	100.0

* For suction at 40 F saturated and condensing at critical point = 87.8 F.

surface is not fouled with lubricating oil. No fouling factor is required on the refrigerant side of a process heat exchanger to reduce the required surface to do a given job and in turn lower the cost of heat exchangers. Also, the nuisance of draining oil from the exchangers is unnecessary.

Space requirements for a packaged refrigerating machine is minimum, i.e., a package centrifugal of the type illustrated in Figure 3 with 100 tons capacity cooling water to 40 F would be approximately 15 feet 6 inches long x 8 feet wide x 6 feet 6 inches high. A similar type machine for 3,000 tons capacity chilling water to 40 F would be approximately 23 feet long x 16 feet wide x 11 feet high. This is startling when you think you can put a machine with 30 times the capacity in a plot plan requiring three times the space of a 100 ton machine. These figures become even more amazing for low temperature refrigeration plants.

REFRIGERANTS

When the designer has determined what mechanical compression system fits the project best he then must select the refrigerant suitable to his requirements.

Among the most commonly used are ammonia, fluorinated hydrocarbons—(list the rest or refer to Table 1), iso-butane, butane, propane, and ethylene. No one of these will have all of the properties to satisfy all refrigeration systems.

In arriving at a decision, consider these points:

1. Type and cost of mechanical equipment required to handle the refrigerant in the gaseous state
2. Thermodynamic properties
3. Physical properties
4. Chemical properties
5. Corrosive action on materials contained in refrigeration system
6. Safety from a fire standpoint
7. Cost of refrigerant
8. Ease of handling
9. Codes

The cost of the mechanical equipment is governed by the volume of gas and the working pressures for which the equipment must be designed to safely contain the gas. For that reason a dense gas with low pressure temperature characteristics will usually result in the lowest cost for the compressor part. Low pressures are desired in that the pressure of the refrigerant in the heat exchanger shells dictates the design working pressure of the shells. This also affects pipe diameter and weight to safely contain the refrigerant.

Comparative characteristics of commonly used refrigerants are listed in Table 1. Included are the latent heat of evaporation, circulation rate of refrigerant on a per ton basis, volume of gas handled per ton, theoretical hp/ton and its efficiency in relation to the Carnot cycle which is the ideal cycle and is a function of temperature levels only.

Most all refrigerants will unite to some extent with water which may react on the oil as well as various materials of which the equipment is made. If the oil, refrigerant, water, etc., is exposed to high discharge temperatures, as sometimes occur in reciprocating machines, sludge will form resulting in corrosion to valves, bearings, the piping system, controls or heat exchangers. For this reason, it is imperative that all water be evacuated from the system before it is charged with refrigerant.

The most likely source of corrosion is from moisture in the system. It causes expansion valves to freeze when operating temperatures are below 32 F. It is also important that the refrigerant selected is not corrosive to or reacts with materials used in the manufacture of the cooling system.

The refrigerant should have non-explosive characteristics to eliminate one more fire hazard in a processing plant, especially if this equipment is installed in areas already heavily laden with explosive gases.

Cost of refrigerant is usually the least expensive item in the entire system. Well packed valves, good gaskets and as many welded joints as possible, will keep refrigerant losses to an absolute minimum. Most refrigerants are stocked in large quantities at distribution points throughout the country and are readily available. Due to their generally low cost the refrigerant should be selected which provides the lowest cost mechanical and process equipment, rather than fit mechanical apparatus to some material with refrigerant characteristics available in your plant.

A comparison of the toxicity and flammability of various refrigerants is made in Table 2.

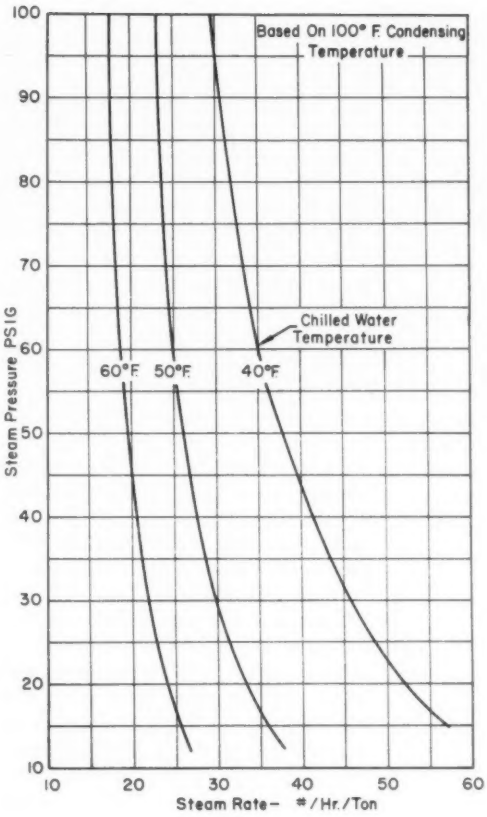
Usually, refrigerants in which hydrogen atoms have been replaced by fluorine and/or chlorine atoms are the least toxic and inflammable. Those hydrocarbons in which the hydrogen atoms have not been entirely removed are moderately toxic and slightly in-

TABLE 2—Relative Safety of Refrigerants

Refrigerant	ASAB9 Safety Code Group Classification	Nat'l Fire Underwriters Group Number	Flammable or Explosive Limits of Concentration in Air
			Percent by Volume
Methane	3[1]	+5	4.9-15.0
Carbontetrafluoride	1[1]	6[1]	Non-Flam.
Ethylene	3[1]	+5	3.0-25.0
Nitrous Oxide	...	...	Non-Flam.
Chlorotrifluoromethane	1[1]	6[1]	Non-Flam.
Ethane	3	5	3.3-10.6
Carbon Dioxide	1	5	Non-Flam.
Monobromotrifluoromethane	1[1]	6[1]	Non-Flam.
Propane	3	5	2.3-7.3
Chlorodifluoromethane	1	5A	Non-Flam.[2]
Ammonia	2	2	16.0-25.0
Azeotrope of dichlorodifluoromethane and unsym-difluoroethane	1	5A	Non-Flam.
Dichlorodifluoromethane	1	6	Non-Flam.
Methyl Chloride	2	4	8.1-17.2
Isobutane	3	+5	1.8-8.4
Sulfur Dioxide	2	1	Non-Flam.
Butane	3	5	1.6-6.5
sym-dichlorotetrafluoroethane	1	6	Non-Flam.
Dichlorofluoromethane	1	...	Non-Flam.
Ethyl Chloride	2	4	3.7-12.0
Trichlorofluoromethane	1	5	Non-Flam.
Methyl Formate	2	3	4.5-20.0
Methylene Chloride	1	4A	Non-Flam.
1, 1, 2-trichloro-1, 2, 2-trifluoroethane	1	4	Non-Flam.
Dichlorethylene	2	4	5.6-11.4

[1]Unofficial.
[2]Very slightly flammable, but for practical purposes considered non-flammable.
Notes: a. National Fire Underwriters Group 1 represents the most toxic with toxicity decreasing as the group number increases.
b. ASAB9 Group 1 refrigerants most safe, with safety decreasing as number increases.

SPECIAL REFRIGERATION REPORT



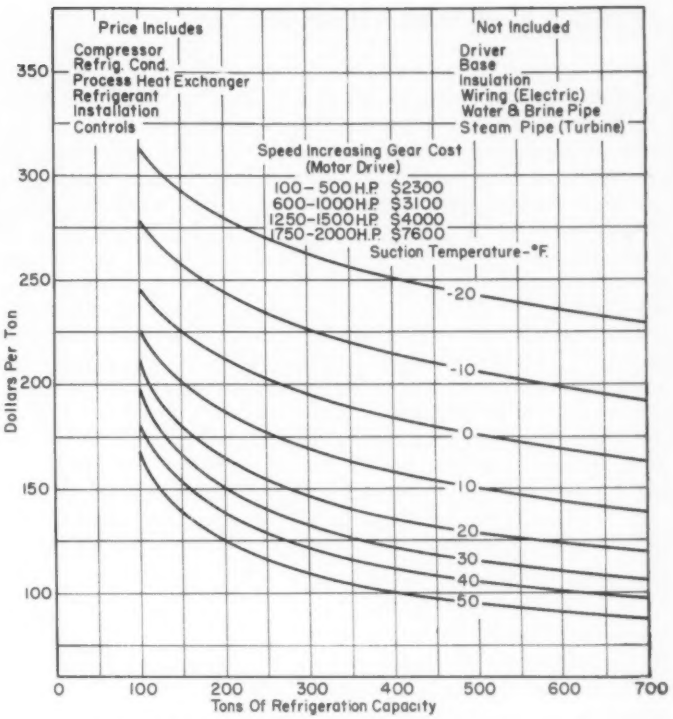


FIGURE 7—(left). Steam rates for jet refrigeration units using 100 F cooling water.

FIGURE 8—(above). Centrifugal compressor refrigeration units cost per ton for various evaporator temperatures.

flammable. The straight hydrocarbons are somewhat toxic and most inflammable.

ABSORPTION REFRIGERATION

Like most refrigeration processes chilling by the absorption method is produced by evaporation of a volatile refrigerant under controlled pressure. It differs from mechanical compression systems in that the refrigerant vapors are absorbed in a liquid absorbent at low pressure, mechanically pumped to a higher pressure governed by the available cooling water, where with the application of heat the refrigerant is evaporated out of solution and condensed. In a compression system, refrigerant vapors are mechanically compressed from the evaporator pressure to the condenser pressure.

Two types of absorption systems are commercially available for large tonnage refrigeration jobs:

Water-Lithium Bromide is gaining favor in the refining, petrochemical and chemical trades. A water-lithium bromide refrigeration absorption machine illustrated in Figure 6, which is available in sizes ranging from approximately 60 to 700 tons capacity. Water is the refrigerant and lithium bromide is the absorbent. It is limited to cooling above 40 F. As noted in Figure 6, the unit consists essentially of two shells housing the generator (lithium bromide concentrator) and refrigerant condenser in the top shell, and the evaporator (or product chiller) and absorber in the lower shell.

Depending on the load, temperature level and number of process streams to be chilled, this machine might best be applied to a system in which chilled water is circulated to the various exchangers. However, it also might be advisable to refrigerate each process stream directly in the evaporator of the machine. Direct chilling of the process stream of course, eliminates a chilled water piping system, pumps and distribution of water to process stream chillers. This in turn substantially reduces the cost of the refrigeration system. These units can be built to handle process streams up to 1,000 Psig working pressure.

In mild climates, this absorption machine can be weatherproofed and explosion-proofed for installing outdoors in the process area. In areas of more severe weather, it is advisable to install this machine in some type of heated shelter.

This absorption machine is designed to operate on low pressure waste steam in the range of 2 to 12 Psig. However, it is not restricted to steam as a source of energy. Any hot process stream in the range of 280 F to 380 F can be used in the unit to provide the required energy. Approximately 20 pounds of steam per hour per ton of refrigeration is used. This, of course, may vary slightly with a specific selection.

The models in this line are equipped with three small solution pumps normally driven by electric motors, but which can be powered by steam turbines. The smallest size requires a total of 5 hp (consisting of 2 at 1½ hp and 1 at 2 hp). The largest takes a total of 14½ hp (consisting of 1 at 7½ hp, 1 at 5 hp, and 1 at 2 hp).

Up to 90 F water can be used for condensing ranging from 3 to 4.5 gpm/ton of refrigeration.

Water-Ammonia absorption machines were at one time commercially

practical. Due to high initial cost, vast space requirements, high cooling water requirements and over-all complexity, it has largely passed from the picture as being a source of refrigeration. Nevertheless, in certain instances it is still purchased since this type absorption system can be used to cool the stream below 32 F.

Here are typical utility requirements: 7 gpm/ton of 85 F cooling water; heat input, 30,000 Btu/hr. per ton at —10 F; 42,000 Btu/hr. per ton at —40 F refrigeration level; aqua ammonia transfer pump requiring 1.0 kilowatt per ton of refrigeration (1.34 hp/ton), when driven by an electric motor. A 100 ton ammonia absorption refrigeration machine then at —10 F needs 3,000,000 Btu/hr. heat input (approximately 3,100 lbs./hr. of steam), 700 gpm of 85 F cooling water and 134 hp electric motor for driving the aqua ammonia pump. A comparable electric driven multi-stage centrifugal refrigeration machine would require a 200 hp motor and approximately 350 gpm of 85 F cooling water.

STEAM JET REFRIGERATION

This system too was more widely used than it is now. Its primary application was circulation of chilled water to heat exchangers for cooling process streams.

Water returned from cooling jackets enters a chamber maintained at a vacuum corresponding to the saturation pressure of the desired leaving chilled water stream. The water is re-chilled by flash cooling. The flash vapors are then removed by a steam jet ejector, which necessitates a constant supply of make-up of water. This water must be of fairly good quality to prevent the concentration of minerals in the machine, forming deposits on heat exchanger surfaces.

Steam jet refrigeration to be used economically depends on whether a fairly large quantity of reasonably high pressure steam (100 psig) is available, an adequate volume of condensing water and sufficient space in which to install the machine. If these requirements can be met, steam jet refrigeration should get consideration for chilling products in the range of 50 F and higher.

Steam requirements for steam jet refrigeration are illustrated in Figure 7.

BUT WHAT DO THEY COST?

The cost of refrigeration systems varies with the machinery used, the system, available utilities, load and temperature level at which refrigeration is accomplished.

Small reciprocating units cooling water to 40 F are available in capacities ranging from 5 to 150 tons. They vary from $250 per ton for the 5 ton unit to $110 per ton for a 100 ton unit. These prices include compressor, cooler, condenser, interconnecting piping and electric motor drive.

Comparative budget costs for centrifugal refrigeration machines are noted in Figure 8 for various temperature levels. Note the prices go up sharply for the low temperatures. The centrifugal is not limited to these temperature levels and refrigeration loads. The inverse effect of size on costs per ton should also be observed. The costs shown include the process heat exchanger or evaporator, compressor, refrigerant condenser, interconnecting piping, refrigerant, freight, rigging, installation and necessary controls. It does not include the cost of special materials, supporting base and the prime mover. When a turbine is used, it is direct-connected to the compressor. When an electric motor or internal combustion engine is used, a speed increasing gear is required.

Where multiple process streams are to be cooled, this machine can be provided without the chiller. In this case, refrigerant can be circulated direct to the several exchangers.

The investment cost of the lithium bromide-water absorption refrigeration machine also varies with the size of the machine and the temperature level to which the process stream is chilled. However, for a standard machine chilling water to 45 F, installed costs run from approximately $225 per ton for the smallest machine to $110 per ton for the largest machine. These costs do not include the installation of the utilities.

The ammonia absorption units range from $1,500 per ton in the smaller sizes (under 50 tons capacity) to $400 per ton for machines over 100 tons.

Costs on steam jet refrigeration equipment hit $200 per ton for small machines and $125 per ton for large machines when chilling water to 45 F.

CONCLUSION

No stock refrigeration machine, system, or refrigerant will satisfy the requirements of all cooling jobs. What might be a good system in one instance might be the worst possible selection in another.

Manufacturers of refrigeration equipment stand ready to provide designers with cost figures, utility requirements, space dimensions and any other recommendations for developing the best refrigeration system for immediate and long-range plans.

As the use of refrigeration expands, it becomes increasingly more important to study thoroughly all aspects of any refrigeration plant to see that it will adequately satisfy cooling specifications, have a just first cost, is economical to operate and will not cause excessive maintenance expense.

BIBLIOGRAPHY

1. A. S. R. E. Data Book, Design Volume, 10th Edition. American Society of Refrigeration Engineers, 234 5th Ave., New York City (1957).
2. Handbook of Refrigeration Engineering, W. R. Woolrich and L. H. Bartlett, D. Van Nostrand, New York City (1948).
3. Ammonia Absorption Refrigeration for Gasoline Plant, The Refining Engineer, No. 7, Vol. 29, July, 1957, p. C-25.
4. Carrier Catalog 17M8 (1956).

About the Author

James T. Robertson is a sales engineer for Carrier Corp., specializing in refrigeration equipment for the process industries. He is in the company's Houston office. A 1950 graduate of Evansville College (Ind.) with a B.S. degree in mechanical engineering, he was employed on Frick Co.'s student engineer program, and joined Carrier in 1952. He was then transferred to the company's Canadian subsidiary, where he remained for four years. Robertson has been in Houston since 1956.

How to operate and maintain . . .

Centrifugal Refrigeration Machines

Here is a short course containing helpful instructions for operating and maintaining centrifugal refrigeration machinery

Paul Ellard, Carrier Corporation, Syracuse, N. Y.

THE CENTRIFUGAL refrigeration machine has probably done more to advance the air conditioning and refrigeration industries than any other development. Its large capacity for producing chilled water, used to cool and dehumidify air, pried the lid from the biggest market for these industries—multistory building air conditioning. Eventually these machines were further developed into special refrigeration units producing temperatures as low as —125 F to chill brine, condense gases, and for other specialized applications.

The range in which centrifugal type units are commercially practical extends all the way from below 100 tons to above 3,500 tons. The top figure is not a maximum capacity, but represents the largest machine required commercially to date. During 1957, 35th anniversary year of unit No. 1., (see box) its 4,000th successor was manufactured by the parent company. Today's largest units provide 15 times as much capacity while taking less than twice the space required by the original machine.

The current trend is toward higher capacities using higher pressure refrigerants. More dramatic advances are heralded for this type of equipment by a tiny compressor-turbine, the size of a football, which has a capacity of 15 tons. This "mighty mite", together with its coils, weighs only 150 pounds. Two such systems will be used aboard one of the new jet transports to provide cooling for air conditioning more than 130 passengers and crew members. This centrifugal works well in an airplane, but more development work must be done before it can be practically applied anywhere else.

HISTORY

The first machine, invented by Dr. Willis H. Carrier, was unveiled before some 300 refrigeration, power and construction engineers May 22, 1922. This machine, a 70-ton water chiller, was on duty at the Onondaga Pottery Co., Syracuse, New York until brought back to Carrier's manufacturing headquarters, also Syracuse, in July, 1958.

As an aid to better understanding your centrifugal water or brine chiller, here is a short course containing helpful instruction for operating and maintaining equipment in your charge.

THE OPERATING CYCLE

In the centrifugal refrigeration cycle, (Figure 1) water or other

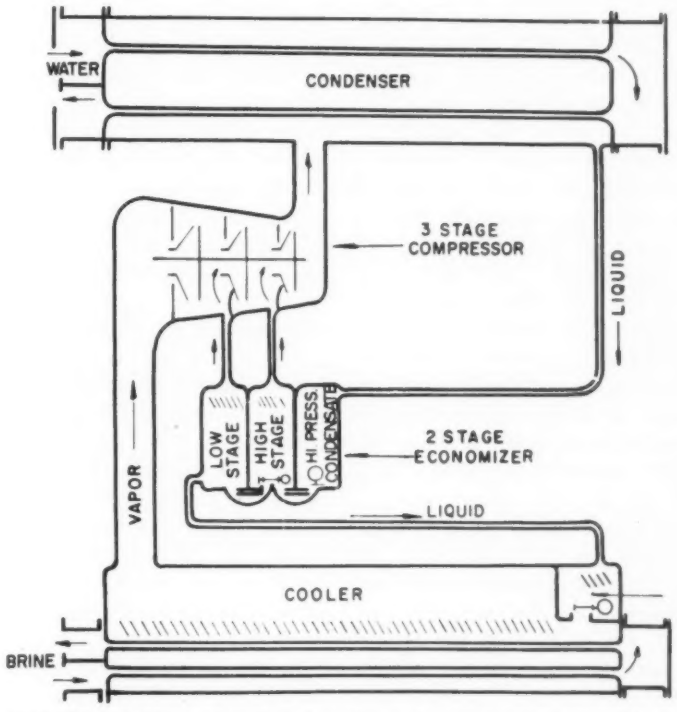


FIGURE 1—This centrifugal refrigeration cycle uses two stage economizer.

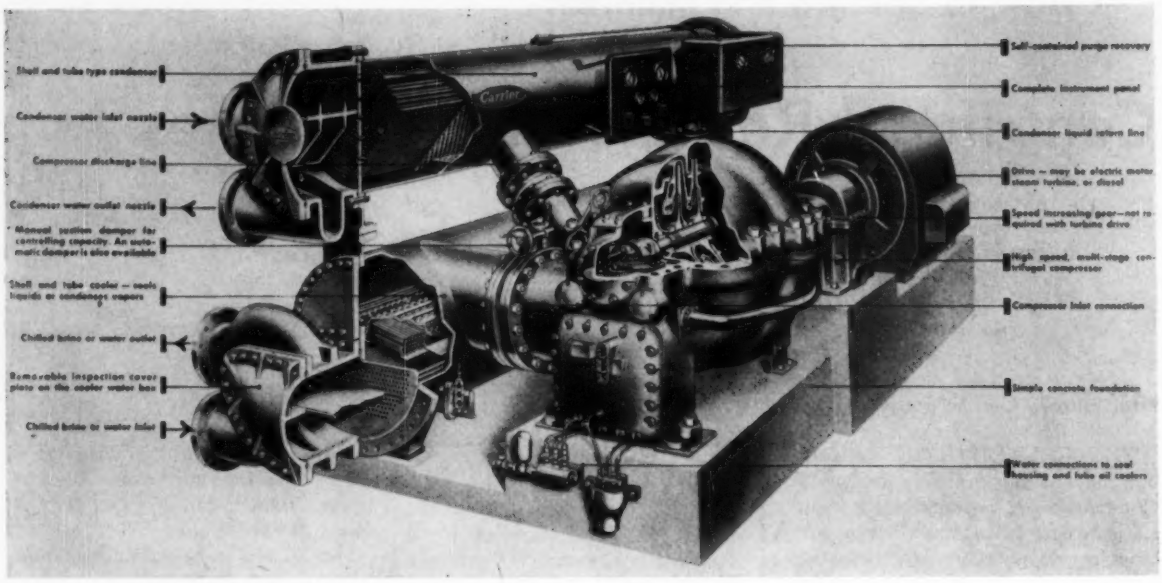

Shell and tube type condenser
Condenser water inlet nozzle
Compressor discharge line
Condenser water outlet nozzle
Manual suction damper for controlling capacity. An automatic damper is also available
Shell and tube cooler — cools liquids or condenses vapors
Chilled brine or water outlet
Removable inspection cover plate on the cooler water box
Chilled brine or water inlet
Self-contained purge recovery
Complete instrument panel
Condenser liquid return line
Drive — may be electric motor steam turbine, or diesel
Speed increasing gear—not required with turbine drive
High speed, multi-stage centrifugal compressor
Compressor inlet connection
Simple concrete foundation
Water connections to seal housing and lube oil coolers

FIGURE 2—These component parts make up a packaged centrifugal refrigeration machine.

liquid being chilled in the tubes of the cooler is chilled by transferring its heat to the cold liquid refrigerant. This causes the refrigerant to boil, and to change to a vapor. The vapor is drawn up into the suction of the compressor. The compressed vapor is forced up into the condenser where its temperature is higher than the water in the condenser tube. The vapor gives up its heat load to the condenser water, and changes to liquid again. The liquid refrigerant drains down to the cooler, and the cycle repeats.

At this point the centrifugal refrigeration machine differs from the reciprocating cycle. Since the majority of centrifugal machines utilize two or more stages of compression (as opposed to normal single-stage reciprocating equipment) an important benefit is realized in the "economizer" cycle.

In this cycle the liquid refrigerant returning from the condenser to the cooler, enters a chamber between two float valves connected by a gas passage to the suction of the second stage impeller. Here the pressure is about halfway betwen condenser and cooler. And a small part of the refrigerant evaporates and goes to the second stage impeller and is pumped back up to the condenser. Because this economizer gas is raised through only half the total pressure range power is saved.

Power saving can be as much as 6 percent. Power can also be saved by adding tube surface but the same effect requires about one-third more tubes, with substantial increases in the weight of machine and contained water and refrigerant.

Where more than two stages of compression are used it is possible to use two stages of "economizer" action. Figure 1 shows a two-stage economizer with a three-stage compressor.

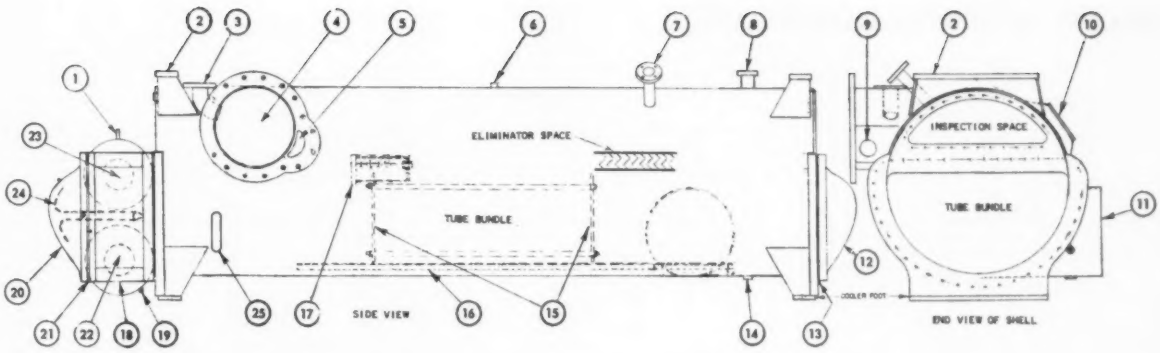
MAJOR COMPONENTS

The centrifugal refrigeration machine, (Figure 2) consists of seven major components. They are: (1) cooler, (2) compressor, (3) condenser, (4) economizer (usually within the cooler), (5) purge, (6) drive and (7) controls. The purpose of each will be briefly described.

1. The cooler is normally of the flooded, shell and tube type (Figure 3). "Brine" (a general term applied to the substance being cooled) passes through finned or prime surface tubes made of copper, copper alloy or steel. They fill about half of the cylindrically-shaped container stretching the length of the pressure vessel. Boiling refrigerant surrounds the outside of the tubes usually ¾ inch in diameter. Other sizes are sometimes used. To prevent liquid boiling over into the compressor, eliminators are placed just above the tubes. Any liquid passing through a compressor would lower capacity and increase horsepower.

Removable covers at each end permit inspection and cleaning of the tubes without disturbing the refrigerant. There is a similar cover on the refrigerant side of the cooler. A liquid level sight glass, refrigerant charging valve, thermometers and safety controls complete essential elements of the cooler.

2. The compressor consists principally of a cast iron or steel casing, rotor assembly, guide vanes and diffusers. (Figure 4) The casing holds diaphragms which separate areas of different pressures and provide gas passages between stages. Guide vanes direct gas into each wheel either with rotation radially or against rotation.



No.	Description	No.	Description	No.	Description
1	Gage And Vent Connection	10	Economizer Support	19	Drain Connection
2	Condenser Support	11	Chamber For Liquid From Economizer	20	Channel Cover
3	Bypass Connection	12	Channel-Plain End	21	Gasket-Channel Cover
4	Cooler Outlet	13	Gasket-Water Box To Tube Sheet-Plain End	22	Brine In
5	Low Stage Economizer Vapor To Compressor	14	Drain And Refrigerant Charging Valve Connection	23	Brine Out
6	Gage Connection	15	Support Sheets	24	Division Plate
7	From Condenser Relief Valve	16	Baffle	25	Sight Glass
8	Rupture Disc Connection	17	Expansion Thermometer Chamber		
9	High Stage Economizer Vapor To Compressor	18	Channel-Nozzle End		

FIGURE 3—A normally flooded cooler of the shell and tube type showing components.

These may be fixed or adjustable. The latter are sometimes furnished to provide a selective capacity range. Journal bearings, to support the shaft; labyrinths to prevent leakage along the shaft; and thrust bearing shoes are other stationary parts.

The rotating elements consist of: (1) a precisely machined, forged steel shaft on which lead coated impeller wheels or stages are mounted, (2) an oil pump, often driven by the main shaft through a worm and gear drive. This may also be located outside the compressor shell, (3) balancing piston (normally used on high-pressure refrigerant machines) mounted on the shaft to reduce thrust bearing load, by applying a gas pressure in the opposite direction to the thrust pressure, (4) flexible coupling to connect the compressor with the drive or speed increasing gear.

Performance of any "centrifugal" as the refrigerating machine is referred to in the industry, is largely dependent upon its seals, which separate inner refrigerant pressure from the atmosphere. Two types of shaft seals are typical of those used on all machines of this kind.

The bellows seal (Figure 5) is recommended where the suction operates under a vacuum, and the compressor is under a vacuum on shutdown. The seal is formed by a rotating ring fastened to the shaft and a stationary seat attached to the seal housing through a bellows. These parts have highly polished metal surfaces which are held tightly together during shutdown by multi-leaf springs. On startup, the oil pressure expands the bellows, moving the stationary sealing seat against the pressure of the spring, and relaxing the pressure on the seal surfaces. Oil flows between the faces of this seat and the rotating seal ring. This positive supply of oil prevents inward leakage of air or outward leakage of gas.

The floating carbon ring seal, often

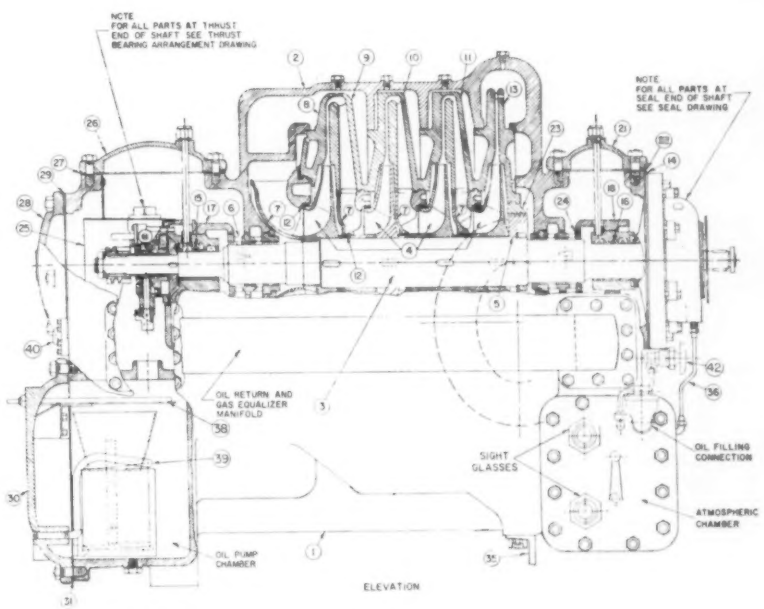

NOTE
FOR ALL PARTS AT THRUST END OF SHAFT SEE THRUST BEARING ARRANGEMENT DRAWING
NOTE
FOR ALL PARTS AT SEAL END OF SHAFT SEE SEAL DRAWING
OIL RETURN AND GAS EQUALIZER MANIFOLD
SIGHT GLASSES
OIL FILLING CONNECTION
ATMOSPHERIC CHAMBER
OIL PUMP CHAMBER
ELEVATION

FIGURE 4—Cross section through a four-stage centrifugal compressor.

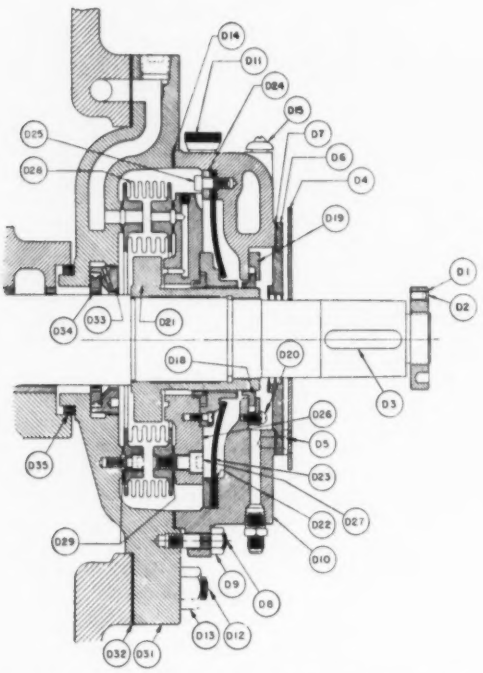


FIGURE 5—Shaft seal assembly of the bellows type is used where the suction operates under vacuum.

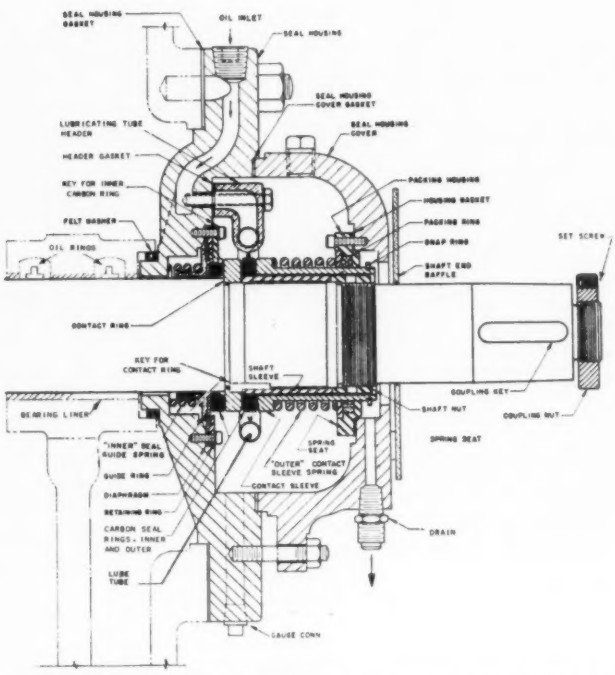


FIGURE 6—Shaft seal assembly of the contact type for higher pressure refrigerant applications.

called the contact seal, is mostly used for higher pressure refrigerant applications (Figure 6). It consists of two special carbon rings held by springs against two highly polished surfaces of a ring which is fixed to the shaft. During shutdown, the inner carbon ring is held firmly against the contact ring by springs. During operation, the lubrication system maintains a pressure in the seal chamber which forces the inner carbon ring to move away from the contact ring. The outer carbon ring is free to rotate or float between the highly polished faces of contact ring and contact sleeve so its rate of rotation is approximately one-half the shaft speed.

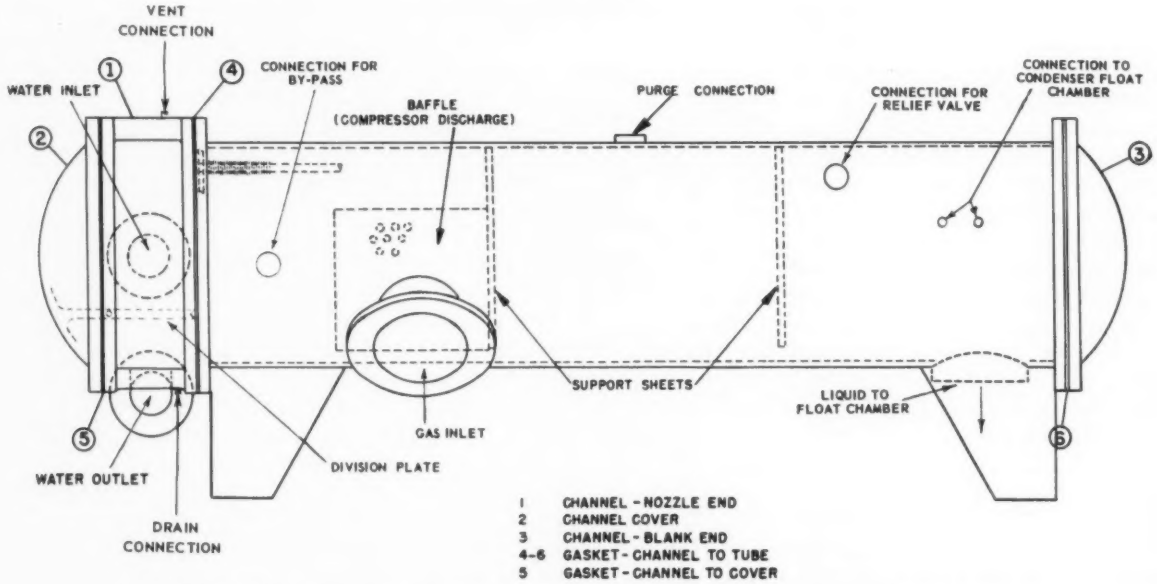


FIGURE 7—These accessory connections on the condenser shell are important for good operation.

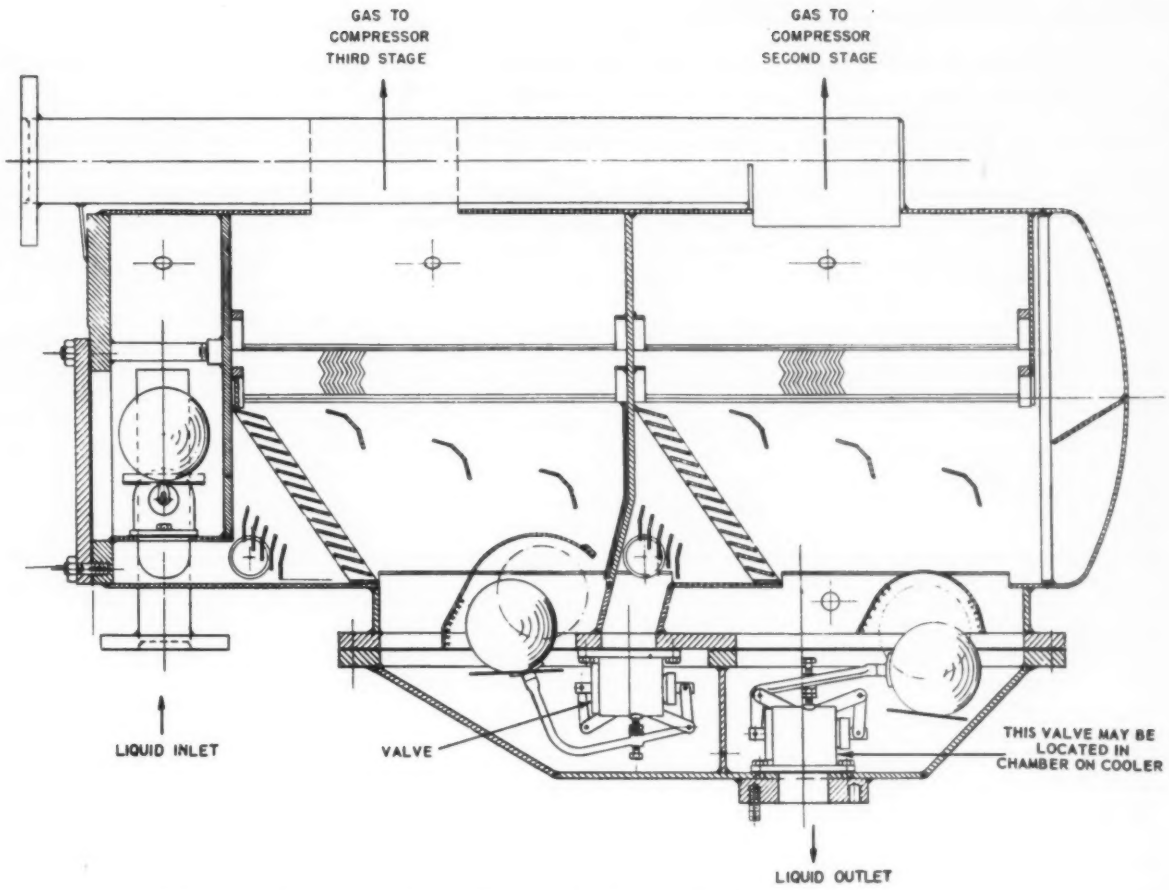


FIGURE 8—This external type of economizer can result in considerable savings in power requirements.

Cooling oil, supplied to the seal, lubricates the moving parts and removes friction heat.

Caution: Due to the high degree of surface finish on the bellows and contact seals, no attempt should be made to make repairs in this area without notifying the manufacturer or his representative.

3. The condenser is usually of shell and tube construction (Figure 7). Composition of the tubes depends upon the cooling fluid, but is usually copper. The coolant water flows through the tubes. The tubes should also be clean and free from scale for best results. Don't trust the eye when looking for scale—scrape the tubes to be sure they are clean. Chemical cleaning is sometimes necessary.

If air should get into the condenser it can blanket the tubes, spoiling heat transfer and raising condenser pressure, thus reducing efficiency. Air

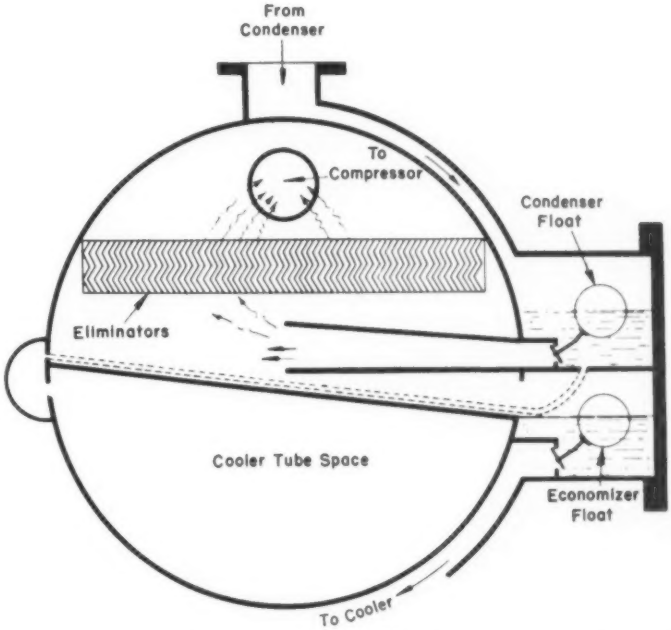


FIGURE 9—Internal economizers such as this are an integral part of the cooler.

can be kept out by purging. A baffle in the condenser forms a pocket to collect air and water vapor, which is removed by the purge. If air leakage persists, a rigid leak detection program will determine the cause and stop the trouble before it becomes a serious problem.

4. The economizer may be either a special external vessel with the required fittings or, more conventionally, it is built into one end of the cooler shell. Figure 8 shows an external type while Figure 9 illustrates the integral type.

This device is an important economy feature of the centrifugal refrigeration machine, hence the name "economizer." The number of economizer stages may vary from one (on a two-stage machine) up to several, but always one less than the number of compressor stages. Thus, it is possible to reduce the refrigerant from condenser to cooler temperature and pressure in three stages when a four stage compressor is utilized. This results in very significant power economy.

5. The purge is a device for removing undesirable gasses from the system with a minimum loss of refrigerant.

Normally, a compressor draws a mixture of refrigerant and gasses out of the condenser, compresses it and passes it on to the purge condenser where air and other non-condensibles remain as the refrigerant gas is liquefied.

As air accumulates under pressure in the purge it opens a relief valve venting itself and a small quantity of refrigerant to the atmosphere. This type of purge is illustrated in Figure 10. Any water present in the system or condensed out of the air floats on the refrigerant. A sight glass indicates the level of water and refrigerant in a separation chamber. Such water is bled to the atmosphere by a hand valve. The refrigerant is automatically returned to the cooler. A record of the amount of water removed should be kept to enable detection of water leakage into the refrigerant from any leak in cooler or condenser.

A new type of purge (Figure 11) has been developed for use with high pressure refrigerants which does not need a compressor. Purged gases are merely passed into a chamber and cooled by a coil through which liquid refrigerant has been expanded. Water and refrigerant are condensed, separated and evacuated. Air is relieved by a solenoid valve which is actuated by a differential pressure switch. This switch closes when air pressure builds up and approaches the pressure of the condenser.

The purge should be run whenever the refrigerating machine is operating. Purging warns of dangerous air and water leaks, saves large maintenance charges and helps insure high efficiency.

The purge should be regarded primarily as a device to indicate leaks in the machine. If air or water are continually being removed from the machine, the leaks should be repaired as soon as possible or corrosive substances will accumulate in the machine and eventually cause serious damage.

6. The drive is usually an electric motor with a speed increasing gear, or a steam turbine. Gas turbines are used in some cases. Diesel and gas engines may be used.

Turbines are ideal drives since they do not require a speed increasing gear, permit capacity control by varying speed and can be selected to operate under most economical conditions in conjunction with other plant steam apparatus.

Synchronous motors may give a power factor improvement but normally require an automatic suction damper for capacity control.

Squirrel cage motors are probably the most popular electric drive. They

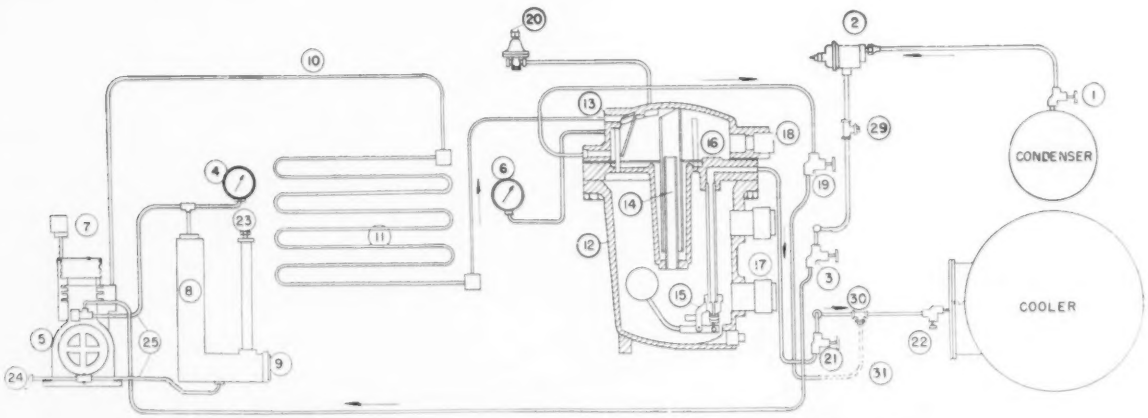
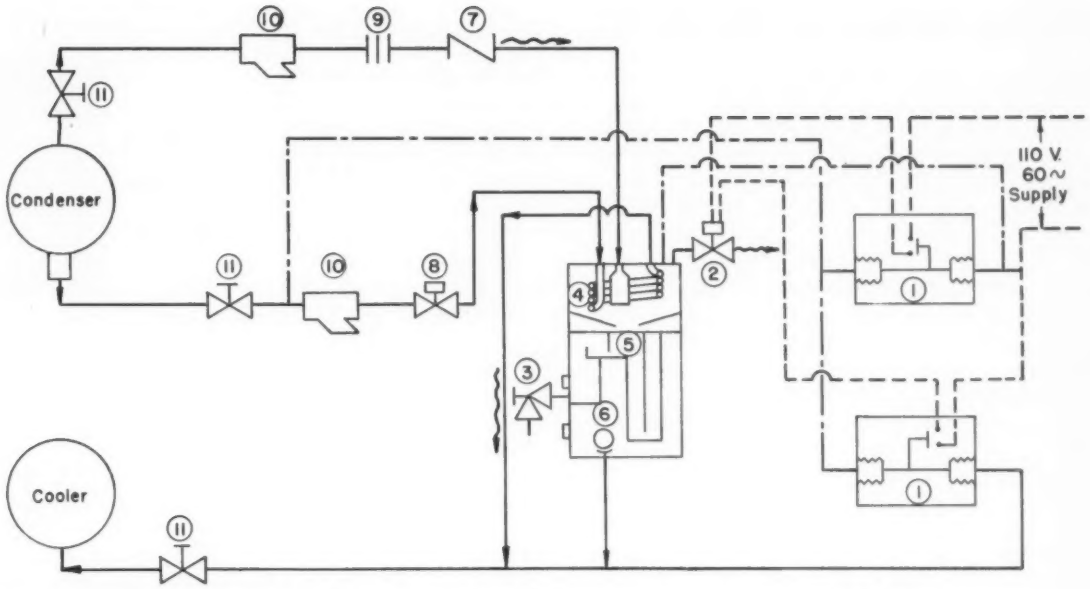


FIGURE 10—Elaborate purge system for large centrifugal refrigeration systems.

LEGEND

1. Stop valve
2. Pressure reducing valve
3. Stop valve
4. Suction pressure gage
5. Compressor
6. Discharge pressure gage
7. High pressure cutout switch
8. Auxiliary oil reservoir
9. Sight glass
10. Compressor discharge line
11. Condenser—air cooled
12. Evacuator chamber
13. Condenser drain line
14. Weir and trap
15. Float valve
16. Equalizer tube
17. Sight glass—refrigerant
18. Sight glass—water
19. Stop valve
20. Automatic relief valve—air
21. Stop valve
22. Stop valve
23. Oil fill plug
24. Oil drain
25. Auxiliary oil reservoir connections
29. Plugged tee
30. Plugged tee
31. Temporary connector pipe



1. Differential Pressurestat
2. Normally Closed Solenoid Air-Relief Valve
3. Water Drain Valve
4. Cooling Coil
5. Separation Chamber
6. Purge Float Valve
7. Check Valve
8. Automatic Expansion Valve
9. Orifice
10. Strainers
11. Shut Off Valves

Symbols

Liquid Flow
Gas Flow
Control Pressure Line
Wiring

FIGURE 11—Thermal type purge for use with high pressure refrigerants.

too, usually require an automatic suction damper for capacity control.

Slip ring motors are often used to vary speed and thus obtain different capacities.

7. Controls are a vital but often neglected part of the centrifugal machine. They serve two functions—safety and capacity regulation. Thermometers and pressure gages indicate conditions at the bearings, oil supply lines, cooler, condenser and purge. They only indicate trouble, if it occurs. Safety controls shut the machine down protecting it against low oil pressure, high condensing pressure, low refrigerant temperature, low brine temperature and sometimes high bearing temperatures.

Capacity controls vary the compressor speed, throttle the compressor suction damper, change the inlet guide vane setting, bypass gas from condenser to cooler, or increase the condenser pressure. These are different ways for achieving capacity regulation. The most efficient method for controlling capacity is through varying speed of the rotor. Throttling compressor suction and changing the inlet guide vane setting provide similar results, and are both good. Bypassing gas from the condenser to the cooler is less desirable and throttling condenser water to raise condenser pressure, is least effective.

Check controls frequently to be sure they are in good operating condition. All thermometers and pressure gages should also be tested to be sure they are giving correct readings. A machine is often reported to be malfunctioning, when the controls are not properly set or thermometers and pressure gages are not sensing accurately.

EASILY ADAPTABLE

Though these machines are usually assembled in the same arrangement, to meet special requirements of industry, they are adaptable to other configurations for efficient performance. While this description is for the "open" type of unit, much of the material is applicable to the hermetic type of machine. The primary difference is the absence of the external shaft seal on the hermetic unit.

CHARGING THE MACHINE WITH REFRIGERANT

The quantity of refrigerant required is customarily specified by the equipment manufacturer. Remember that, in the flooded type of cooler, the refrigerant level on shutdown should not submerge all the tubes. When the machine is placed in operation, the refrigerant boils and covers the remaining tubes with foam thus making all heat transfer surfaces effective. Eliminators of various designs prevent liquid from being dawn into the compressor with the evaporated refrigerant. If too much refrigerant is added, liquid may enter the compressor by flooding the eliminators thereby increasing drive horsepower required and reducing capacity. The correct charge is normally about two-thirds of the height of the tube bundle at shutdown.

To determine a correct charge, add refrigerant until the difference between leaving brine and cooler temperatures is at a minimum. Do not be concerned by the indicated level during operation if the unit is functioning properly. When the machine is running the refrigerant sight class gives erratic readings on occasions.

The machine should be checked periodically to see that there is no deviation from the normal operating temperatures, i.e., the difference between the leaving "brine" temperature and cooler refrigerant temperature will increase if the charge is not sufficient. Refrigerant should be added to reduce this leaving differ-

ence if a change in level is noted. It almost goes without saying, if one or more units are operating in the same plant, but with different refrigerants, care should be taken to see that the correct refrigerant is put into each machine.

OPERATING YOUR UNIT

Specific details for starting and stopping should be obtained from the manufacturer. Here are general instructions covering most motor driven refrigeration units on air conditioning duty.

1. Check oil levels
2. Start the purge
3. Start condenser water flowing
4. Start "brine" circulating
5. Check the control air supply
6. Close the suction damper as much as necessary to start the machine-open when the machine reaches speed.
7. Close the holding circuit for the safety controls by holding in button on motor panel.
8. Bring machine up to speed observing the oil pressure—if pressure does not develop in approximately 10 seconds, stop the machine and re-start.
9. Adjust the oil cooler water flow to give normal bearing temperatures (usually under 180 F).

The key to success in operating and maintaining a centrifugal refrigerating machine is to understand *how* it operates and *why*. To help you do this, manufacturers issue operating and service instructions and customarily provide a period of instruction. Service representatives of the manufacturer are there to help you with any questions or problems you may have concerning your equipment. These people are interested in working themselves out of a job because of the trouble-free operation of your equipment.

About the Author

Paul Ellard is a service engineer for Carrier Corp., Syracuse, N. Y. He handles home office coordination of service and installation activities on open type centrifugal refrigeration machines. A registered professional engineer in New York, he has B.S. and M.S. degrees in mechanical engineering from Columbia University, and taught there as a graduate assistant from 1952-53. Ellard spent 15 months as a development engineer on Carrier centrifugal refrigeration machines, and 36 months as maintenance and construction supervisor on a Naval Station in Japan. He has been with Carrier in his present capacity for a year.

TABLE 1

TROUBLE-SHOOTING YOUR UNIT

Here's a list of troubles that may occur and their cause. For more serious problems, the manufacturer's service representative should be consulted.

Indication of Trouble	Causes
High Condenser Pressure	Water valves throttled—pump not operating—tubes or strainer plugged—tower not operating properly—tubes scaled—air in condenser—float valve stuck—broken division plate
Low Condenser Pressure	Water too cold—insufficient refrigerant charge
Suction Damper Operating Improperly	No control air—linkage or damper binding—controller not operating properly
Low Refrigerant Level	Float valves not operating—leak in machine or purge
Low Capacity	Condenser not performing properly—hot gas by-pass valve open—excessive oil in refrigerant—brine flow not correct—division plates broken or by-passing—tubes scaled—speed not high enough—low refrigerant level
Compressor Surges	Light load—air leak—high condenser pressure
Low Oil Pressure	Dirty oil filter—oil pressure regulator out of adjustment—low compressor speed—low condenser pressure—excessive clearances
High Oil Pressure	Pressure regulator out of adjustment
High Bearing Temperature	Low oil cooling water flow—excessive refrigerant in oil—oil heater on—bearings damaged
Purge Not Operating Properly	Thermal overload burned out—high pressure cut out open-air cooled condenser fouled—shut-off valves closed—power off—belt broken—float valve stuck—reducing valve stuck—compressor valves worn or out of adjustment
Noisy Couplings	Misalignment — insufficient lubrication—worn
Motor Overloaded	High chilled water flow or temperature—suction damper open—too much refrigerant
Gear Overheated	Improper oil level—fouled oil cooler—not enough water to oil cooler — misalignment — loose coupling nut
Controls Not Operating Properly	Tampering—corrosion—control charge lost

Where it stands today and . . .

What's the Future for Static Switching

The conventional metal-to-metal switch is becoming obsolete. Three new roads look promising: magnetic, superconductor and electroradioactive switching

C. R. Olson and R. A. Ramey
Westinghouse Electric Corp.
Pittsburgh, Penn.

The switching art today centers itself about the metal-to-metal contact. The relay, contactor and switch are electromechanical marvels long developed and brought to a high state of perfection and low cost. These devices set a tough objective for any substituting science, particularly in respect to element cost. However, there are certain weaknesses and uncertainties—limited life, low-speed operation and arcing. When we look at the problems about us and recognize the added complexity of future generations of apparatus, we know we must find another way of switching both power and information-handling circuits.

The two avenues which show promise and are receiving much attention today are the magnetic and semiconducting solid-state sciences. Almost every phenomenon associated with these sciences seems to be under exploration. We are even looking at effects at superconducting temperatures.

Magnetic Switching. In the last few years we have seen the advent of magnetic amplifier controls for a wide variety of applications. The development of suitable materials has allowed this technological advance. In all these there is a single theme—the exploitation of the phenomenon of saturation in ferromagnetic materials. To understand one of these devices is to understand them all. A magnetic core wound as a transformer (Figure 1) can withstand an applied voltage until the time integral of that voltage saturates it. Thenceforth there can be no change in magnetic flux to provide a counter emf and current will flow unimpeded. Two states exist—saturated and unsaturated. There have been invented hundreds of special circuits whose function is to control the apparent magnetic flux level in the core and thus determine the time of switching.

Widespread acceptance of magnetic switching devices as reliable circuit components is based upon the transformer art which has a long history of reliability. The magnetic amplifier experience accumulated to date has completely vindicated that trust. The most critical applications are now unhesitatingly assigned to magnetic amplifier switches. In all cases, the magnetic switching system is superior to relays except in the matter of cost. This deficiency will also be overcome.

Semiconductor Switching. Another approach to the switching problem is through use of the solid-state "vacuum." It is not often recognized that crystalline substances provide nature's most perfect vacuum so far as electrons are concerned. We are accustomed to imagining electrons traversing a vacuum from cathode to anode in a tube and being influenced therein by electric fields. Such is the case, with certain conceptual variations, in crystals. The most useful of these are the semiconducting metals germanium and silicon. When electrons are injected into the crystal from metal contacts, these electrons are free to move through the crystal in the same manner as through a vacuum tube. Thus, these crystals can be thought of as vacuum tubes whose filaments cannot burn out and whose envelopes cannot leak. In efficiency, ultimate reliability, speed and physical size, these devices cannot be equaled in low-level applications such as computers. Development is now under way to increase the size of these devices so that power switching of hundreds of kilowatts with a single device will be commonplace. Present limitations are about one kilowatt per unit.

There is a wide variety of semiconductor switches vaguely corresponding to the variety of vacuum and gas tubes. These include the transistor, the analog of DeForest's friode, the trinistor or controlled rectifier which corresponds to the thyratron and ignitron, the dynistor which corresponds to the trigger tube and the Zener diode which corresponds to the voltage regulator tube.

Figure 2 is the physical configuration of an npn transistor. The silicon slab is effectively a solid-state vacuum to which are attached three junctions.

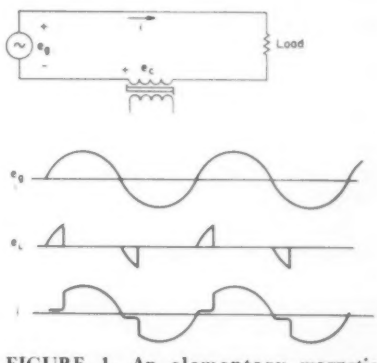


FIGURE 1—An elementary magnetic switch is only a magnetic core wound as a transformer.

Two of these junctions are rectifying with the orientation indicated by the rectifier symbols. These are the collector and emitter. The third junction is an ohmic contact called the base. Peculiar to the rectifying junction is its ability to inject electrons into the solid-state vacuum as a heated filament injects electrons into a normal vacuum. The ohmic contact, of course, cannot inject electrons into the solid-state vacuum any better than it can in a usual vacuum.

If we trace the load circuit from the base through the load and power supply to the collector, we find there can be no current flow so long as no electrons exist in our solid-state vacuum. The collector junction is so biased that it cannot inject electrons. Now consider the control circuit with zero voltage from the signal source. Since there exists no net voltage to allow the emitter junction to inject electrons into the solid-state vacuum, there can be no current flow.

However, if a small voltage is applied to the control circuit (Figure 2), the emitter junction injects electrons into the heretofore insulating region. With the presence of electrons the solid-state vacuum becomes a conductor and load current is able to flow. When the cloud of electrons is present in this base region, the rectifying junction at the collector ceases to block the applied voltage. Thus, it can be seen that the controlled injection of electrons modulates load current.

Unlike electron tubes in which conduction is accomplished only by electrons, often the semiconductor switch is constructed to allow conduction by "holes" which are the electrical equivalent of positively charged particles. Such a device is a pnp transistor. The availability of the two types of devices makes remarkable and useful combinational circuitry. For example, the connection of an npn and a pnp transistor gives us a device having characteristics similar to that of a thyratron. This is called a trinistor or double-base diode.

These devices, when used in switching applications, have very small size for their rating and very low loss. At the present time junction areas of 80-mil diameter will conduct 5 amperes and block 200 volts (test values). It is believed that 1000-ampere, 1-inch diameter, 1000-volt solid-state switches will be developed within a decade. This will cause a major revolution to take place in our technology.

Another phenomenon under investigation is the Hall effect. It has long been know that certain materials, such as bismuth, change resistivity upon application of a magnetic field. Today's research has centered upon the magnetoresistive properties of semiconductors. The change of resistance of most conductors upon application of a magnetic field is hardly detectable; the new materials show responses tens of thousands of times greater. Changes in resistance in the order of 100 to 1 are being observed in the laboratories.

The key to this problem is the finding of materials in which electrons can move with great speed. Contrary to most concepts, electrons moving in metals drift along as if they were passing through a viscous fluid. In such materials as indium arsenide the density of electrons is very much lower than with copper, but here the electrons which are free to move are less hindered in their movement—they have greater mobility. When one solves the equations of motion of charges under the above two sets of conditions, he finds that the electrons moving in indium arsenide are enormously more deflected by a magnetic field than those in copper; hence, the corbino disc (Figure 3) as a variable resistor. If a magnetic field is applied perpendicular to the current flow, the electrons will move in spiral paths. The greater the magnetic field, the more spirals required in the transit across the disc and hence the longer the path and the higher the apparent resistance of the disc. At the present time this effect is being investigated for the switching of power circuits. This effect may someday provide motor starters. In information-handling circuits, the Hall generator (Figure 4) is providing a practical means of measuring currents, magnetic fields and power.

Superconductor Switching. A still more exotic area of study is the field of superconductors. Certain metals exhibit a sudden transition to the superconducting state at certain critical temperatures. The temperature at which this transition takes place can be influenced by the application of a magnetic field (Figure 5). When a magnetic field is applied, a superconducting metal can be made to switch to an ordinary conductor exhibiting resistance. Thus two states can be effected.

Figure 6 shows the elemental "cryotron" configuration. It is simply a tantalum wire wrapped with a niobium wire. The tantalum wire has its state changed by the magnetic field; the niobium is always superconducting. The individual components are so small that one has to look closely to see them. When a current flows through the niobium coil, the tantalum conductor exhibits resistance.

Electroradiative Switching. Another new kind of solid-state switching device is termed the electroradiative relay. It is an excellent analog of the familiar electromechanical relay and therefore, will be easy to apply in many of the switching and logic circuits presently using the electromechanical relay. The type of electroradiative relay currently being developed is a combination of two solid-state elements: an electroluminescent plate and a photoconductive cell. The first element is essentially a layer of phosphor which emits visible radiation under the influence of an alternating voltage. The second element is typically a thin layer of cadmium sulfide; it has a high resistance to the flow of electric current when in the dark, but under moderate illumination this resistance is reduced by three to five orders of magnitude. The elements are placed face to face, as shown in

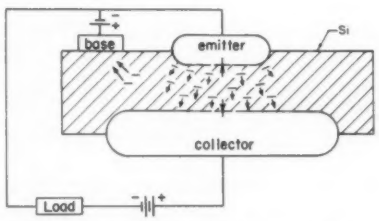


FIGURE 2—Electrons from emitter change solid-state vacuum into a conductor.

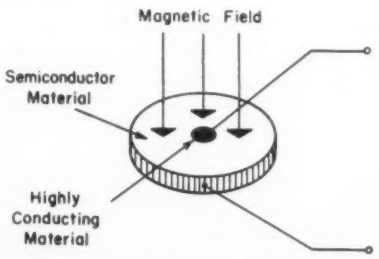


FIGURE 3—The Corbino disc may someday provide a new kind of motor starter.

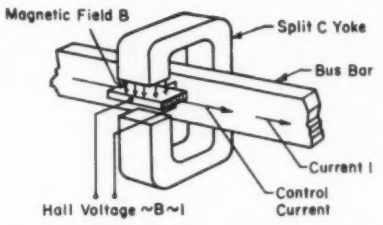


FIGURE 4—The Hall generator measures currents, magnetic fields and power.

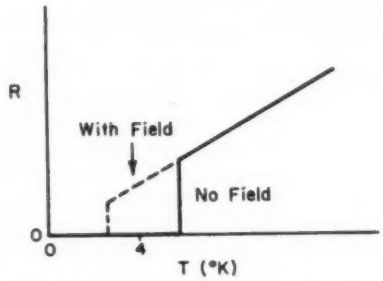


FIGURE 5—Tantalum exhibits sudden transitions to the superconducting state at certain critical temperatures.

Figure 7, and encapsulated light-tight to form an electroluminescent-photoconductor type of electroradiative relay. An electromechanical relay is also shown schematically in Figure 7 to illustrate the analogy. The electroluminescent plate is analogous to the relay coil; its two leads are the input terminals. A multiplicity of photoconductors can be illuminated by one plate, analogous to many sets of normally open contacts. When no power is applied, the photoconductors are dark and present essentially an open circuit between their leads, the output terminals. When the electroluminescent plate is excited by an alternating voltage, it emits light and the photoconductors present a low resistance path, essentially a closed circuit.

Applications. Beyond performing its required job, any equipment used by the petroleum industry ideally should have certain basic characteristics. First, it must be reliable. Its operation should be noncritical so that it will perform properly under less than ideal conditions and without continual adjustment. Second, the equipment must not introduce any additional fire or explosion hazards. And finally, almost as a part of reliability, it should not be affected by corrosion and dirt.

Static switching devices inherently have many characteristics which make them well suited to meet these requirements. By definition, they have no moving parts; this removes the element of wear, corroded or dirty contacts, arcing, and the possibility of frozen bearing surfaces. The potential life of many static switching devices is almost unlimited with no detectable drift in operating characteristics. The operating power levels of some can be low enough in performing logic or computational functions to be intrinsically safe in hazardous locations. Most can be encapsulated or hermetically sealed—long a dream of your industry. And, operated in the switching mode, systems with the ability to operate over a wide range of conditions (such as supply voltage) are quite possible.

Power Handling. Some of the most interesting static switching speculations are for power-handling applications. Some of the new developments such as power transistors, dynistors, and trinistors show possibilities for handling large blocks of power efficiently and economically. Allowing sufficient time for the still needed research and development work, the petroleum industry will have available completely static motor controls. These will include hermetically-sealed static motor starters and protective relays, as well as more sophisticated controls such as variable speed motor controls. The motor starter itself, being completely encapsulated or sealed, will be suitable for location anywhere (at least in Division 2 areas). Motor controls will probably also include static protective relays in the package with the motor starter. Actually, the motor starter complete with protective relays, can easily be visualized as a part of the motor. Static switching devices someday will also replace, to a large extent, circuit breakers and change the whole philosophy of fault interruption.

For more sophisticated control functions, such as variable speed control of pump drives, we can again look to static switching. Static rectifiers and static controllable inverters can be teamed to provide variable frequency. Then we will have the simplicity and reliability of squirrel-cage induction motors giving us all the desirable features of variable speed.

Information Processing. The other broad area of application for static switching is information processing. This ranges from communications and supervisory control, alarm and annunciating systems, interlocking and sequence control, to complex process control and computer technology.

For communications functions, we normally do not think of switching devices. However, digital or switching functions are very important (for example, in such fields as telemetering, supervisory control and remote data-logging). Speed and accuracy in the transmission of information are vitally important especially when the information is used in computations such as economic dispatch problems, cost studies, and the much dreamed-of field of over-all refinery control. Only digital techniques can provide the accuracy necesary for accounting-type operations. High speed is also necessary because the amount of information processed is immense.

Communication systems of this type, like power-handling systems, are useful throughout your industry. They are useful for telemetering pressures, flows, levels, etc., for (1) production control (i.e., field gathering and remote custody transfer control), (2) pipe line supervisory control, telemetering and remote dispatching control, and (3) refinery data-logging and remote or automatic control of blending, dispatching and process control.

Computers. Computers of course, are one of the largest users of static switching devices. Computers will be used for making all types of economic studies, processing studies, and in gas and oil pipeline dispatching. They are and will be used in determining most economic shipping schedules and most economical blends of available components to meet market requirements. They will be used

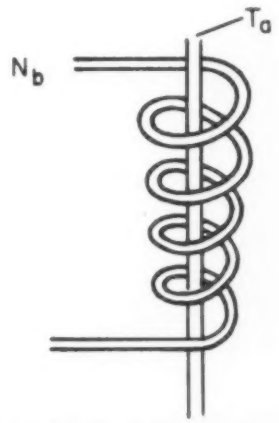


FIGURE 6—The elemental cryotron is a tantalum wire wrapped with a niobium wire.

for evaluating the geologist data, and in helping the operator to determine the optimum production for his oil fields. They will be used in the design of processing equipment and as part of the process. Static switching devices are used by the thousands in computers to provide their tremendous capacity for data processing and information storage.

The large, much-publicized, general purpose computers are capable of handling many of these tasks. They are particularly well adapted to accounting work, long-range economic studies, engineering and design studies and other problems not tied in with real time. For real time problems, such as continuous process control, blending and mixing control, periodic telemetering and data-logging, the large-scale computer is not practical. In these areas, the special purpose computer, tailored to the particular chore, is the answer. One example of special purpose computers is a digital blending and mixing or proportioning control.

Blending and mixing controls offer almost ideal applications for static switching devices. Since positive displacement meters are normally used, generated pulses can be used to indicate the meter revolutions. These pulses can be handled very neatly by various static switching devices to accumulate and store the total quantity

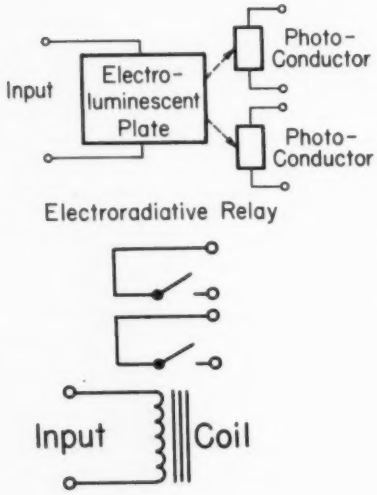


FIGURE 7—The electroluminescent plate is similar to the relay coil.

and the accumulated errors and to correct for these errors. It is also possible to see how these techniques are useful in solving automatic custody transfer and gas or oil pipeline dispatching problems.

Since the special purpose computer is not and cannot be defined specifically, almost any process control utilizing computer techniques could be so classified. Processing control of the future—automation, if you like—is different in your industry than in many others. You are not looking particularly for lower labor costs—in many instances labor has been reduced to a fire watch. Your processing control must increase profits by other routes—more efficient use of utilities, improved recovery and separation of products, increased throughputs, or the combination of all of these.

A specialized computer-type process control has been developed as one possible answer to this problem. This is an automatic experimenting control in which a number of controllable variables are adjusted automatically according to a preplanned strategy to arrive at the optimum operating point. This optimum point will most often be maximum profit—computed continuously by another part of the same control.

Although computers are obtaining a great portion of the publicity in automatic control today, and rightly so, there are many other aspects of control which can utilize static switching devices. They may be somewhat less glamorous, but nonetheless important.

For example, throughout the petroleum industry, there are innumerable applications for alarm and annunciator systems. Presently, most of these systems use relays. However, static switching devices are invading this field. Also at the present time, most of these alarm and annunciator systems depend on contact making primary sensing devices. There are available, however, static devices to detect some of these conditions including strain gauge pressure switches, differential transformer pickups for various functions, temperature-sensitive resistors, etc. Development work is all that is necessary to couple these with static annunciators to provide completely static sealed alarm systems for protective functions.

In addition, static proximity switches are available and offer considerable promise in the control field. Proximity limit switches can be used as scraper detectors and to indicate valve position, including check valves with no exposed stem. This brings almost within our grasp the possibility of complete static sensing, alarm, annunciator, interlocking and sequence control for applications such as pipe line pumping stations and refineries.

The Future. Let's look ahead a few years to see what these developments and others will mean to the petroleum industry. Static switching can be looked at as one of the major tools of the second industrial revolution. The first substituted machines for muscle power; the second revolution is under way supplying the brain power and nerves for the mechanical muscles. The net results of this system of control, communication, and power handling will be lowered costs, improved products and better service.

We mentioned process control, economic dispatch, blending and mixing—these are not the traditional fields for electrical engineers in this industry. But these thoughts prophesy the future. Tomorrow's control will be electric—perhaps not next year, or even five years from now; most definitely, though, within ten or fifteen years. Control will require the talents of many electrical engineers for overall control system design, communications, servo and computer techniques, etc. Men will be needed who understand the complex integrated systems from the analytical instruments to the motor shaft. We have a dual task: to keep ourselves ahead of the ever onrushing tide of developments by self-education and to see that these developments are put to use both within and outside the confines of tradition.

BIBLIOGRAPHY

1. "The Dynistor Diode, A New Device for Power Control," A. P. Kruper, *Proceedings of the 21st Annual Machine Tool Electrification Forum*, 1957.
2. "The Hall Effect and Its Uses," T. R. Lawson, Jr., *Westinghouse Engineer*, May, 1957.
3. "Unique Properties of the Four-Layer Diode," W. Shockley, *Electronic Industries*, August, 1957.
4. "Static Switching Devices, New Tools for Industrial Control, R. A. Mathias, *Control Engineering*, May, 1957.
5. "Cypak and Its Application in the Petroleum and Chemical Industries," P. G. Hanna and C. R. Olson, AIEE Conference Paper 58-227.
6. "Operation of a Low-Temperature Memory Element," C. J. Kraus, Transistor and Solid-State Circuits Conference, February, 1958.
7. "Magnetic Computer," T. H. Bonn, *Electronics*, August, 1957.

Originally presented before the AIEE Fifth Electrical Conference of the Petroleum Industry, Dallas, September 15, 1958.

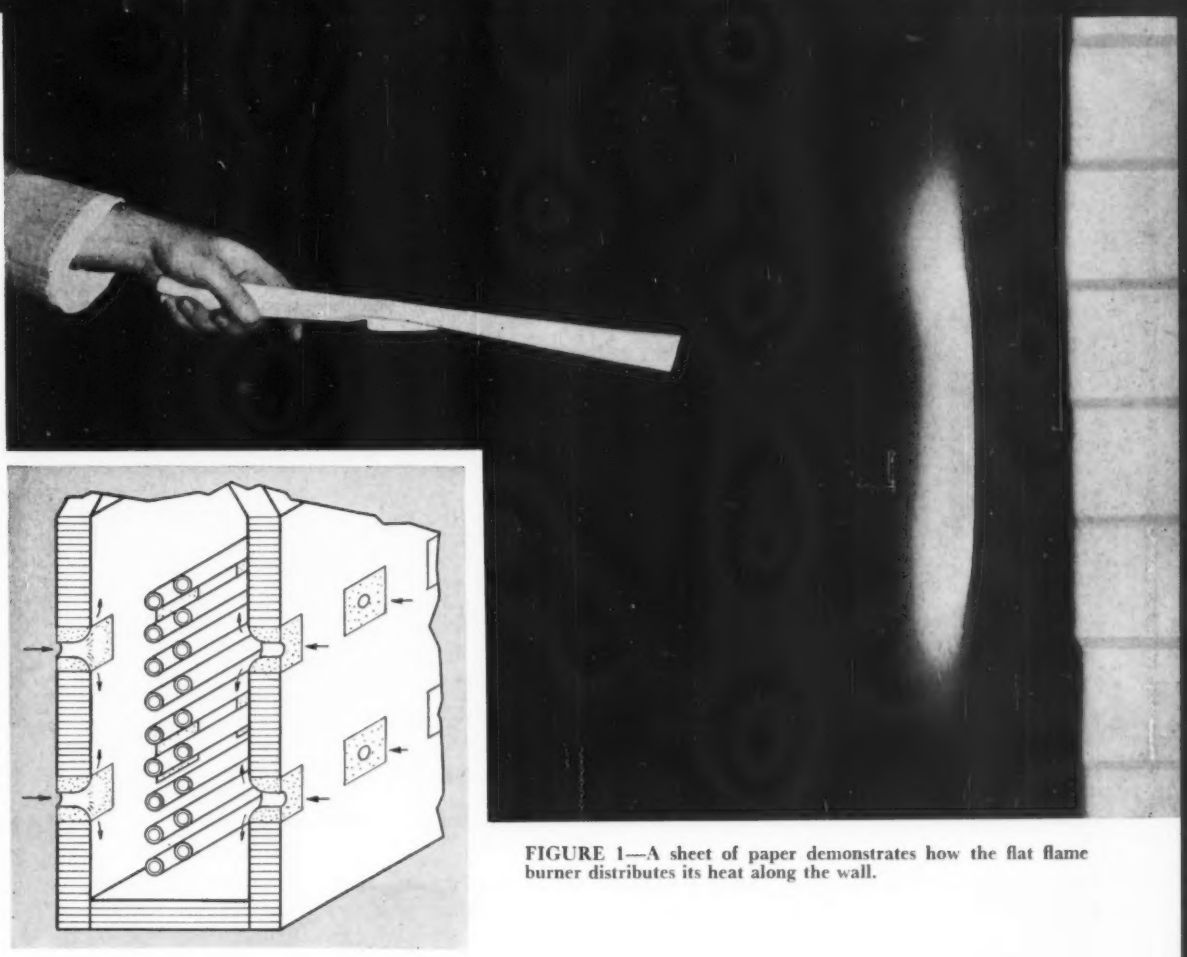


FIGURE 1—A sheet of paper demonstrates how the flat flame burner distributes its heat along the wall.

Burner Design Gives More Uniform Heat

The advantages of using a flat flame burner for direct-fired heaters are discussed

H. W. Morgan and R. J. Reed
The North American Manufacturing Company, Cleveland

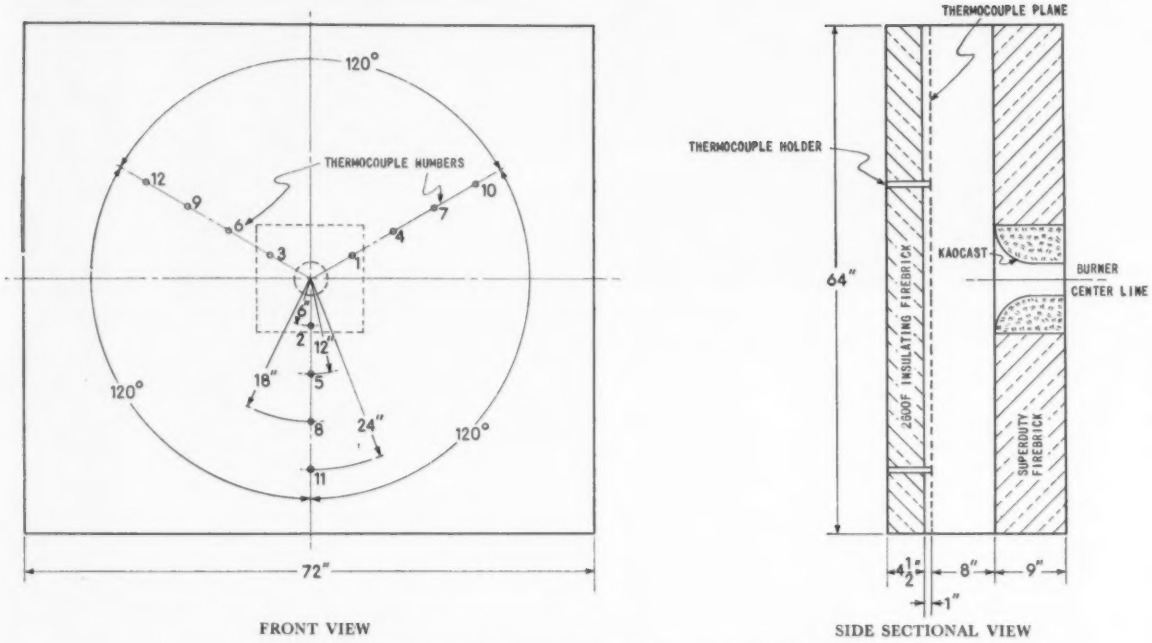
A FLAT FLAME type of burner is ideally suited to direct-fired process heaters because the new principle of directing the flame along the wall, instead of forward, provides such uniform heat transfer. Some of the advantages of this design are as follows:

- Better process control
- Improved coil and refractory life
- More compact heater installations
- Fewer burners per coil.

An analysis of heat distribution requirements for process heaters indicates the need for maximum heat input per unit of tube surface area, with uniformity sufficient to avoid local overheating of the tubes that might result in coking of the fluid or even tube failure. An ideal arrangement would consist of a burner and heater design that would spread a sheet of flame parallel to a bank of tubes. This is a requirement similar to that of many metallurgical and ceramic furnaces.

Tests Were Conducted. Two sets of tests were conducted to determine the uniformity of heat release from a new type of nozzle-mix gas burner whose flame fans out in all directions over the surface of the wall in which the burner is installed. The manner in which

Burner Design Gives More Uniform Heat . . .



FRONT VIEW SIDE SECTIONAL VIEW

FIGURE 2—Thermocouples are used to measure the distribution of flame.

heaters might utilize this new flame configuration to reduce heater size (and cost) while maintaining better than normal heat distribution is shown in Figure 1. The "morning glory" shape of the burner tile embodies a new heating principle in that it permits the flame to scrub the entire refractory wall (instead of just its own tile wall) thus converting the *whole* wall to a source for radiant heat transfer to the coil.

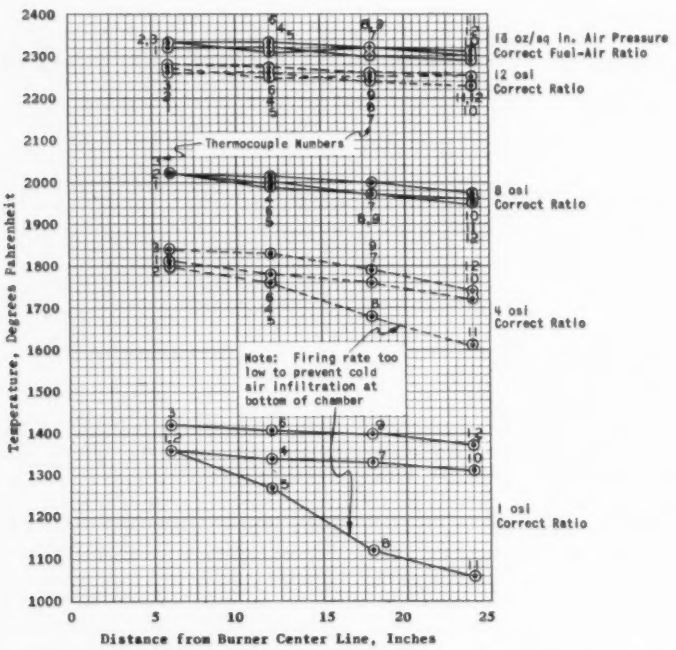


FIGURE 3—The bricks in the test wall were laid without mortar; therefore, cold air infiltration was experienced at low firing rates.

The first tests were conducted to measure the uniformity of flame distribution around the burner center line. One "flat flame" burner (3-inch air pipe size) was installed in the 64-inch-by-72-inch wall of a 64-inch-by-72-inch-by-9-inch refractory chamber with thermocouples located in a plane 8 inches away from the burner wall as shown in Figure 2. Figure 3 gives the resulting temperature pattern at various firing rates. Since there was no load in this furnace, each firing rate produced a different temperature level, but comparison of temperatures for any given rate indicates the uniformity of the flame pattern. Since the brick walls were laid up without mortar the furnace was not tight, resulting in considerable cold air infiltration due to stack effect, when operating at low firing rates. This cold air entering the bottom of the furnace caused the drop of the temperatures indicated by the thermocouples Nos. 5, 8, and 11, in the 4 oz/sq in. and 1 oz/sq in. tests. All other curves of Figure 3 indicate a remarkably even heat distribution even at points 24 inches from the burner center line and 120° apart. (Maximum deviation of the three most remote thermocouples was only 40°.)

Heat Absorption Studied. The second series of tests actually simulated

Burner Design Gives More Uniform Heat . . .

at some cost in efficiency. The reasons

a section of a direct-fired process heater and compared the heat absorption in eight different areas. This second set of tests was conducted to duplicate (thermally) a section of a proposed new direct-fired process heater. Two 2-inch burners were installed 4 feet apart in an 8-foot-by-1½-foot-by-4-foot high refractory chamber. Laboratory limitations required the substitution of vertical ¾-inch black iron pipes for the horizontal coil. A constant flow of cold city water was passed through the "coil" and the water temperature was measured by thermocouples located at regular intervals along the length of the pilot heater. (See Figures 4 and 5.) The temperature difference between adjacent thermocouples served as a measure of the heat absorption in that section of the coil. It should be noted that this constituted a very severe test of uniformity since the coil was kept at a lower than normal temperature level by the cold water inlet temperature so that temperature equalization and heat soaking by re-radiation were practically negligible.

The temperature rise between each pair of thermocouples is shown in Figure 6 with the burners operating at full firing rate (16 oz/sq in. air pressure; 580,000 Btu per hr per burner) at correct fuel-air ratio. An adjustment on the burner permits variation of the lateral deflection of the flame, and Curve Y-4 of Figure 6 shows that moderate deflection provided the best heat distribution for the test configuration of tubes, burner, and wall. Since the flame deflection is readily adjustable, the best flame shape can easily be ascertained for any arrangement. The ratio of maximum to minimum heat flux rates for equivalent sections was only 1.2 in Test Y-4. It is understood that this ratio is about 1.5 with conventional firing methods. The "morning glory" type burners of Test Y-4 were spaced farther apart than in conventional heaters, indicating that better uniformity was achieved with fewer burners.

It is interesting to note that in the pilot heater with the coil 16 inches from the front face of the burner tile and wall, full flame deflection resulted in slight cold spots in front of the burners whereas a flame with no deflection produced minor hot spots. There are, of course, infinite variations between

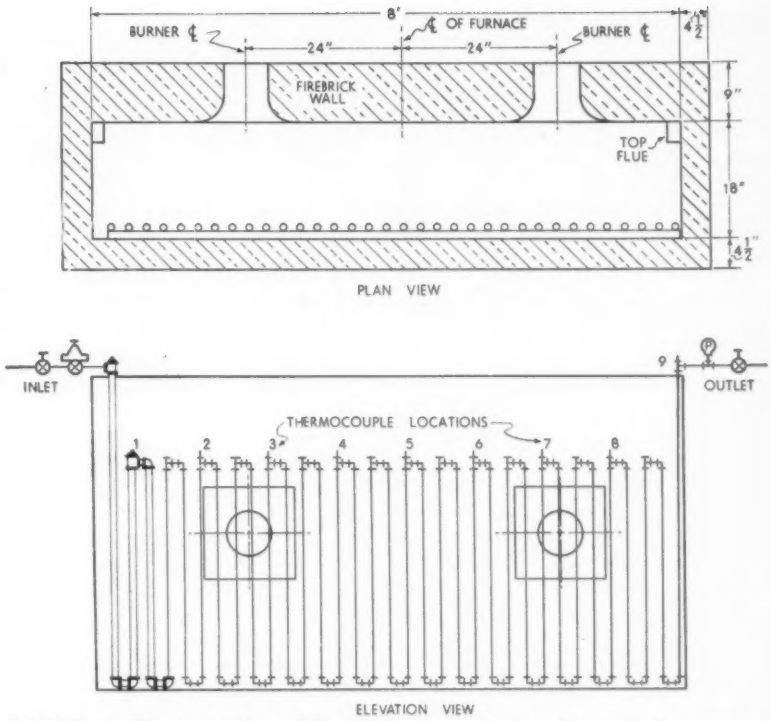


FIGURE 4—The temperature difference between adjacent thermocouples serves to measure the heat absorption in each section of the coil.

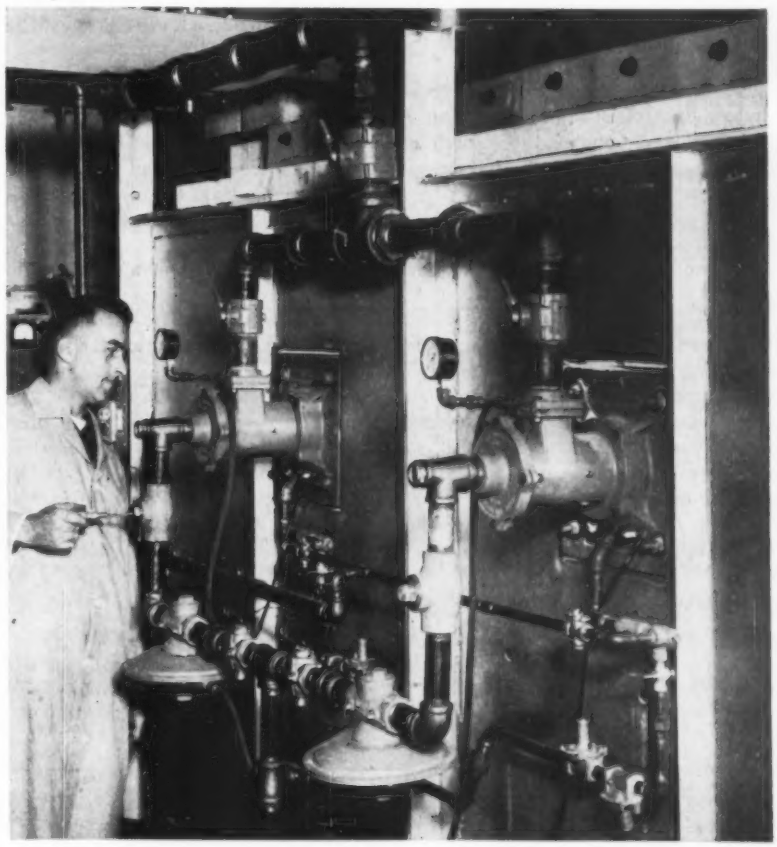


FIGURE 5—Author Morgan makes the initial fuel-air setting on one of the burners.

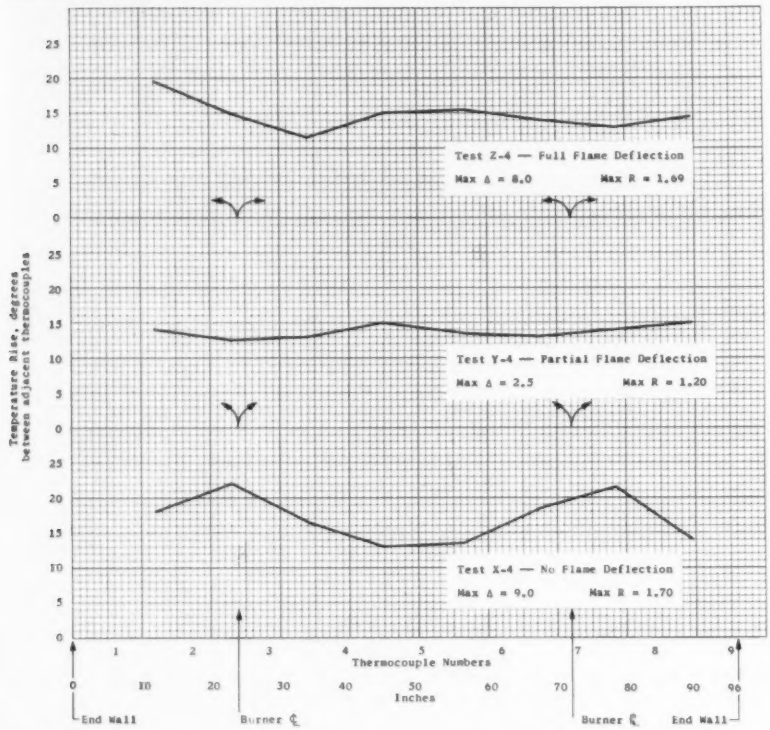


FIGURE 6—The firing rate and air-fuel ratio were the same for all three of these tests.

these two extremes; so it is possible that an even better distribution than Curve Y-4 could be obtained by something other than the degree of partial deflection arbitrarily selected for this test. This flame deflection can be changed in the field by a quick, simple adjustment and can then be locked in position.

Suggested Control Schemes. The deflection imparted to the flames of this new type of burner is a function of the momentum of the air stream. When the burners are throttled to very low firing rates this momentum may be reduced to the point where the flat flame shape is lost. Table 1 lists approximate visible flame dimensions determined when the burners were operating at correct fuel-air ratio in the open at indicated air pressures, with the flame shape adjustment set for full deflection. These dimensions should be used only as a guide in selecting burners because the area of heat release extends beyond the visible limits of the flame.

The flat flame burner is a sealed-in burner providing all of the air for combustion through the burner, under control. This feature makes possible accurate control of the fuel-air ratio for best economy. The flame is also very stable over a wide range of fuel-air ratios other than stoichiometric (from 10 percent excess fuel to 150 percent excess air). This wide stability range allows the furnace designer considerable latitude in selection of control schemes and coil materials.

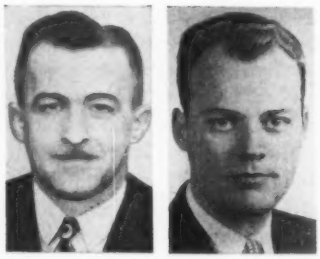
Excess air can improve uniformity at some cost in efficiency. The reasons for the improved uniformity are (a) reduced maximum temperature differential between heat source and heat sink, (b) higher furnace pressure with consequently less cold air infiltration, and (c) greater agitation to eliminate stratification while facilitating convection heat transfer. The use of excess air not only widens the turndown range, but in the case of flat flame burners it also serves to maintain the momentum required for the flat flame shape at low fuel input rates.

The use of excess air to maintain uniformity while turning down to low input rates should be considered as a control scheme if oxidation and reduced fuel economy at low firing rates are not serious problems. This can be accomplished most simply by throttling the gas flow while leaving the air on at full rate, or most economically by using biased cross-connected regulators with the control device throttling the air flow.

TABLE 1—Flat Flame Dimensions

BURNER SIZE, Inches	FLAME DIAMETER, Inches			MAXIMUM FORWARD TRAVEL FROM TILE FACE, Inches		
	16 oz/in.	4 oz/in.	1 oz/in.	16 oz/in.	4 oz/in.	1 oz/in.
1¼	13–15	10–12	6–7	3–4	4–5	6
1½	15–17	13–15	6–8	2–3	3–4	4–5
2	22–24	19–21	13–15	3–4	4	4–5
2½	24–26	20–22	10–12	3–4	4	4–5
3	28–32	18–22	10–12	3–4	4–5	6
4	32–36	20–24	10–14	3–4	4–5	6

About the Authors



Morgan Reed

H. W. Morgan is an application engineer for The North American Manufacturing Co., Cleveland. He attended the Carnegie Institute of Technology, where he graduated with a B.S. degree in mechanical engineering. Before joining North American, Morgan was a fuel engineer at The A. M. Byers Co., Ambridge, Penn.

R. J. Reed is an application engineer in charge of the Sales Engineering department for The North American Manufacturing Co., Cleveland. He has a B.S. degree in mechanical engineering from Purdue University, and an M.S. degree from Case Institute of Technology. Reed was an instructor in heat power engineering at Fenn College from 1946-48, and an instructor in mechanical engineering at Case Institute from 1948-50. He has been with North American since 1950.

The first step necessary in the solu-

cost, the manufacturing cost, and the transportation cost at each refinery.

Linear programing tells you how to . . .

Run Several Refineries the Best Way

Here is a practical problem solved by linear programing. It shows how to operate each of several refineries to achieve optimum total results

George L. Landsly
Hammond, Ind.

SINCE A LINEAR programing solution gives an answer which most efficiently allocates resources, it is a most natural method to be used in all types of scheduling. That is, a linear programing model could be used to schedule individual processes or even entire oil refineries in order that maximum profits could be realized. Although there is a current awakening of management to the uses of linear programing, many practical applications have been bypassed in the petroleum industry.

Linear programing is a mathematical model by which optimal solutions can be obtained. That is, given a problem with certain limitations and a property to be optimized (maximized or minimized), the "best possible solution" can be obtained by a series of mathematical manipulations once the given data has been expressed in appropriate form. A detailed and understandable presentation of this method is given by Prof. A. Charnes in his book entitled, "An Introduction to Linear Programing."[1] The following is a typical problem which shows how this method can be applied.

How Should Output Be cut. Current economic conditions have caused the curtailment of many oil companies' production output. This example problem involves the reducing of total output in an oil company's six refineries in such a manner that total contribution is maximized. The total refining capacity in this company's system is 405,000 bpd. The capacity at each of the six refineries is shown in Table 1.

The limitations to be placed on the solution of this problem are as follows:

- The combined cutback must represent only about 20 percent of the total refining capacity. Thus, the system must produce somewhere between 300,000 to 350,000 bpd.
- A refinery cannot produce more than its rated capacity.
- The cutback at any one refinery should not be more than 50 percent of its rated capacity.

The reasons for choosing the last limitation are listed as follows:

1. The variable cost per barrel at any one of the refineries is nearly

This article will tell you . . .

The best goal for a process or even an entire refinery can be obtained by a series of mathematical manipulations once the data have been expressed in appropriate form. The method of linear programing then is a convenient way to arrive at the optimal solution.

Here are six refineries for which maximum throughput is not needed. The problem is to decide how much to cutback each of the six refineries to achieve maximum profits. Costs are figured for each of four main items: production, marketing, transportation and manufacturing. These cost items are then combined in a simple table.

The author presents this example problem in a stepwise manner. The program is tabulated as it would appear before solution. Another table shows the results. Although the author does not go into the fine points of mathematics needed for linear programing, he demonstrates one of the many uses for this method in the petroleum industry.

TABLE 6—Problem Solution

constant from the 50 percent output level on up to full capacity.

2. The present labor force at any one refinery would not suffer excessive layoffs at output levels of 50 percent or greater. Thus, this limitation somewhat protects the interest of the community.
3. The complete shutdown of any one refinery would be costly in view of both future start-up costs and facility deterioration expenses.

The first step necessary in the solution is to determine the contribution per barrel from each refinery. From accounting data, the sales volume in dollars and in barrels can be obtained. Using this information, the average income per barrel could be determined as follows:

$$\text{Sales} = \$1{,}451 \text{ million}$$
$$\text{Volume} = 244 \text{ million bbl.}$$
$$\text{Average Income} = \frac{1{,}451}{244} = \$5.95/\text{bbl.}$$

The contribution figure from each refinery can now be found by subtracting from the average income figure the production cost, the marketing cost, the manufacturing cost, and the transportation cost at each refinery.

The production cost (crude oil production and exploration) can be assumed to vary directly with total output marketed and is assumed not to vary between refineries. The total production cost is $219 million. Therefore, the average production cost at each refinery is then the following:

$$\frac{\$219}{244} = \$0.90/\text{bbl.}$$

The marketing cost (selling expense, advertising expense, etc.) can be assumed to vary directly with total output and not to vary between refineries. The total marketing cost is $56 million. The average marketing cost at each refinery is then the following:

$$\frac{\$56}{244} = \$0.23/\text{bbl.}$$

The transportation cost to and from each refinery is directly proportional to the distance involved. This cost at each refinery is given in Table 2.

The manufacturing cost is directly related to the number of employes, the average hourly labor rate, and the output at each refinery. Manipulating the relationship between these factors at capacity gives the manufacturing cost at each refinery. The output per employe could be held constant by reducing the work force, and, therefore, the calculation based on capacity operation will be valid.

The manufacturing cost at refinery No. 1 is given as an example:

$$\text{Cost} = \frac{(\text{Hr. rate})\,(24 \text{ hr/day})\,(\text{No. employes})}{\text{refinery capacity}}$$
$$= \frac{(3.17)\,(24)\,(6{,}870)}{209{,}000}$$
$$= \$2.50/\text{bbl.}$$

TABLE 1—Refining Capacity Available

Refinery No.	Capacity, bpd
1	209,000
2	74,000
3	50,000
4	32,000
5	22,000
6	18,000
Total	405,000

TABLE 2—Transportation Costs

Refinery No.	Cost, $/bbl
1	0.20
2	0.22
3	0.21
4	0.50
5	0.29
6	0.30

TABLE 3—Manufacturing Cost

Refinery Number	Avg. Labor Rate, $/hr	No. of Employes	Capacity, bpd	Cost, $/bbl
1	3.17	6,870	209,000	2.50
2	2.91	1,300	74,000	1.22
3	3.02	1,600	50,000	2.32
4	2.45	310	32,000	0.58
5	2.77	410	22,000	1.21
6	2.62	760	18,000	2.55

TABLE 4—Refinery Contribution to Profit

	DOLLARS PER BARREL						
	Costs						
Refinery Number	Production Cost	Marketing Cost	Transportation Cost	Manufacturing Cost	Total Variable	Average Income	Contribution
1	0.90	0.23	0.20	2.50	3.83	5.95	2.12
2	0.90	0.23	0.22	1.22	2.57	5.95	3.38
3	0.90	0.23	0.21	2.32	3.66	5.95	2.29
4	0.90	0.23	0.50	0.58	2.21	5.95	3.74
5	0.90	0.23	0.29	1.21	2.63	5.95	3.32
6	0.90	0.23	0.30	2.55	3.98	5.95	1.97

TABLE 5—Problem Statement

X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	P_o
2.12	3.38	2.29	3.74	3.32	1.97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1						−1	−1													105,000
	1							−1												37,000
		1							−1											25,000
			1							−1										16,000
				1							−1									11,000
					1							1								9,000
1													1							209,000
	1													1						74,000
		1													1					50,000
			1													1				32,000
				1													1			22,000
					1															18,000
1	1	1	1	1	1													−1		300,000
1	1	1	1	1	1														1	350,000

NOTE: Empty cells in body of tableau have zero entries.

TABLE 6—Problem Solution

X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	P_0	C_j/C_i
2.12	**3.38**	**2.29**	**3.74**	**3.32**	**1.97**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		
0	0	0	0	0		1	0	0	0	0	1	0	—1	—1	—1	—1	0	0	1	58,000	0
	1						0	0		0	0	0	1		0		0		0	74,000	3.38
		0	0	0			0	0		0		0			0		0	1	0	50,000	0
			1						0						1					32,000	3.74
				1						0						1				22,000	3.32
0	0	0	0	0	0						1						1	0		9,000	0
0	0	1	0	0			0	0	0	0		0		1			0	0		50,000	2.29
	0						0	0		0	—1	1	1	1	1	1	0		—1	46,000	0
	0	0	0	0			0	1	0	0		0		1			0	0		25,000	0
			0						1						1					16,000	0
				0						1						1				11,000	0
1	0	0	0	0	0		0	0	0	0	1	0	—1	—1	—1	—1	0	0	1	163,000	2.12
0	0	0	0	0	1						—1						0	0		9,000	1.97
0	0	0	0	0	0		1	0	0	0	0	0	1		1		0	0	—1	37,000	0
Z_j-C_j row 0	0	0	0	0	0	0	0	0	0	0	.15	0	1.26	.17	1.62	1.20	0	0	2.12	920,630	Z_0

The manufacturing cost for the other refineries are listed in Table 3.

The total variable cost for each refinery can be obtained by adding together each of the individual costs. The contribution figure can then be obtained by subtracting this sum from the average income figure. These calculations are summarized in Table 4.

The Problem in Analytical Form. In order to maximize total contribution, the sum of the product of the refinery's contribution figure and of the output must be maximized. This does not mean that the product of contribution and of output at each refinery should be maximum, but that the sum of the six refineries product should be maximized.

The problem expressed numerically is:

Max. Total Contribution $= 2.12X_1 + 3.38X_2 + 2.29X_3 + 3.74X_4 + 3.32X_5 + 1.97X_6$ where the coefficients are contribution values in dollars per barrel and the variables $X_1, X_2 \ldots X_6$) represent the output at each refinery.

The limitations that are to be placed on the solution are as follows:

- The output at each refinery must be at least 50 percent of its rated capacity. For example, at Refinery No. 1:

$$X_1 \geqslant 105{,}000 \text{ bpd};$$
Similarly, $X_2 \geqslant 37{,}000$ bpd;
$X_3 \geqslant 25{,}000$ bpd;
$X_4 \geqslant 32{,}000$ bpd;
$X_5 \geqslant 11{,}000$ bpd;
and $X_6 \geqslant 9{,}000$ bpd.

- The output at each refinery cannot exceed its rated capacity. For example, Refinery No. 1:

$$X_1 \leqslant 209{,}000 \text{ bpd};$$
Similarly, $X_2 \leqslant 74{,}000$ bpd;
$X_3 \leqslant 50{,}000$ pbd;
$X_4 \leqslant 64{,}000$ bpd;
$X_5 \leqslant 22{,}000$ bpd;
and $X_6 \leqslant 18{,}000$ bpd.

- The total output for the six refineries must be equal to or greater than 300,000 bpd and equal to or less than 350,000 bpd.

$$\text{Thus, } X_1 + X_2 + X_3 + X_4 + X_5 + X_6 \geqslant 300{,}000 \text{ bpd, and}$$
$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 \leqslant 350{,}000 \text{ bpd.}$$

TABLE 7—Total Contribution

Coeff.	Output, bpd	Return, $/bbl	Contribution, $
X_1	163,000	2.12	345,560.00
X_2	74,000	3.38	250,120.00
X_3	50,000	2.29	114,500.00
X_4	32,000	3.74	119,680.00
X_5	22,000	3.32	73,040.00
X_6	9,000	1.97	17,730.00
X_7	58,000	0.00	0.00
X_8	37,000	0.00	0.00
X_9	25,000	0.00	0.00
X_{10}	16,000	0.00	0.00
X_{11}	11,000	0.00	0.00
X_{12}	0	0.00	0.00
X_{13}	46,000	0.00	0.00
X_{14}	0	0.00	0.00
X_{15}	0	0.00	0.00
X_{16}	0	0.00	0.00
X_{17}	0	0.00	0.00
X_{18}	9,000	0.00	0.00
X_{19}	50,000	0.00	0.00
X_{20}	0	0.00	0.00
Total Daily Contribution			$920,630.00

Apply Linear Programing. Upon compiling and formulating the above data in appropriate form, it can be represented in a simplex linear programing model. Because of the inequalities in the problem, the introduction of "slack variables" is necessary. These slack variables will be indicated as $X_7, X_8 \ldots X_{20}$. These slack variables can be thought of as additional operations which absorb some portion of the refinery's capacity, but which contribute nothing to the dollar contribution. Thus the problem would look like Table 5 after it is set up.

After several mathematical manipulations, the optimal solution is obtained, and it is shown in Table 6, while the final summation is given in Table 7. As indicated, the total contribution received from this solution is $920,630.00—the maximum amount possible. The system is operating at about 86 percent of capacity.

Let's Analyze the Results. The capacities as expressed previouly are the optimal outputs at each refinery as far as total contribution is concerned. That is, X_1 through X_6 represents the appropriate output at each refinery. The values given for X_7 through X_{12} represent the amount of output produced over the minimum allowable at each refinery. The values given for X_{13} through X_{18} indicate the amount of idle capacity at each refinery. The term X_{19} represents the amount of total output produced over the minimum allowable amount for the six refineries. Similarly, X_{20} represents the amount of output under the maximum allowable.

The dollar values in the last row of Table 6, entitled, "$Z_j - C_j$ Row," represent the marginal cost of a barrel per day of idle capacity at each refinery. For example, the value of X_{12} in the $Z_j - C_j$ row is $0.15 which means one additional bpd of idle capacity at Refinery No. 6 "costs" $0.15. Whereas at Refinery No. 2, the cost would be $1.26 as indicated by X_{14}. That is, if one bpd of output is shifted from Refinery No. 2 to Refinery No. 1, the loss in contribution would be equal to $1.26.

This example demonstrates a practical use for linear programing in the petroleum industry. It is not intended to teach the technical aspects of linear programing, but it is intended to create interest in this scientific tool.

LITERATURE CITED

[1] *"An Introduction to Linear Programing"* by Charnes, A.; Cooper, W. W.; and Henderson, A.

Survey Reveals Lubricants Made

Production of lubricants in the United States surveyed by the National Lubricating Grease Institute. Next survey to include Canada

OVER ONE BILLION POUNDS of lubricants were produced in the United States during 1957, according to figures released by the National Lubricating Grease Institute. U.S. manufacturing gave their production data on lubricating greases and fluid gear lubricants in the first survey of production ever conducted. Unofficial sources estimate that 85 percent of total production in the United States was represented in the totals, based on known facilities. Production figures were used to prevent the possible duplication that sale and re-sale might bring if marketing totals were employed.

Yearly production represented by the survey was about 582 million pounds of lubricating greases and about 474 million pounds of fluid grease lubricants. The table shows the soap types which were represented by the grease production figures along with the yearly production of each.

Classification of returns according to size showed 11 of the 48 firms reporting produced less than 1 million pounds of lubricating grease, 14 firms produced more than 1 million or less than 5 million, while 23 firms manufactured 5 million pounds or over.

The breakdown of fluid gear lubricants was 19 firms making less than 1 million pounds, 11 producing from 1 to 5 million, and 18 in the 5-million or over bracket.

With over 95 percent of the industry reflected in its U.S. membership, the Grease Institute's board of directors felt such a high response was an excellent beginning and have authorized the compilation procedures for a second survey, on 1958 production. It is anticipated that an even larger percentage of manufacturers will participate and that the 1958 figures will begin to be of historic significance when compared to 1957's totals.

Because of the success of the first survey, NLGI members in Canada asked to be included in the tabulation of 1958 production. Procedures will be identical but separate Canadian totals will be offered in the final report. Both American and Canadian manufacturers are receiving questionnaires now. The closing date is March 31, 1959. The management services division of Ernst & Ernst, nationwide certified public accountants, will again conduct the survey for the Grease Institute.

Summary of Production Surveyed

LUBRICATING GREASES	Pounds Reported	Percent
Aluminum soap	27,142,543	4.66%
Calcium soap	218,844,369	37.61
Lithium soap	160,462,383	27.58
Sodium soap	128,859,083	22.15
Other soap	28,680,446	4.93
Non-Soap (Inorganic thickener)	17,891,004	3.07
TOTAL	581,879,828	100.00%
FLUID GEAR LUBRICANTS	473,999,270	

Chassis Grease—Going, Going, Gone?

on the road was accomplished by

Chassis Grease—Going, Going, Gone?

Less grease fittings and longer greasing intervals can spell doom for automotive grease unless improved greases and new markets can be developed

W. M. Drout, Jr., and N. L. Jenkins
Esso Standard Oil Company
New York City

THE AUTOMOTIVE grease market is a dynamic market. It reflects both the rapidly changing technology of the automobile industry as well as the changing technology of the grease industry itself.

Originally grease was (by today's standards) simply a soap thickened oil. It was designed to provide a film of lubricant between moving surfaces so as to reduce friction and wear. However, our society has always anticipated and looked for better products. This is true of grease. Many improved products which reduced friction and wear and provided many other highly desirable characteristics were developed.

The search for improved products was spurred on by the expanding automobile industry. Although new products had to be developed, such as greases which could withstand the far more severe washing action of water and the erosive action of dust, the automobile industry provided a tremendous growth potential for grease products. On the other hand, it also provided an incentive to develop techniques which would minimize or eliminate the use of greased bearings.

The perfect solution to most greasing problems, particularly that of recurring greasing, would be the development of a low cost, long life, frictionless bearing, which could be sealed against the intrusion of foreign bodies. In many ways the successful attainment of this solution would seem impossible. However, the competitive aspects of the automobile business has compelled each automobile company to search for ways of providing a more desirable product. Their never ending search for technological advances has been reasonably successful. As far as grease is concerned, it is reflected in the 56 percent reduction in number of chassis fittings in the past seven years. In turn, this partial success spurs further study. Each automobile company hopes that it can gain a competitive advantage by being first to develop the car which does not have to be greased.

It is quite difficult to estimate when, or if, a technological breakthrough permitting the elimination of grease fittings will occur, and whether it will occur in one step or a series of steps. The experts, namely the automobile manufacturers, feel rather strongly that complete elimination of fittings is only a matter of time. The more optimistic feel that this will occur within three years. The more conservative feel that this will take place within five years.

The rather complete agreement

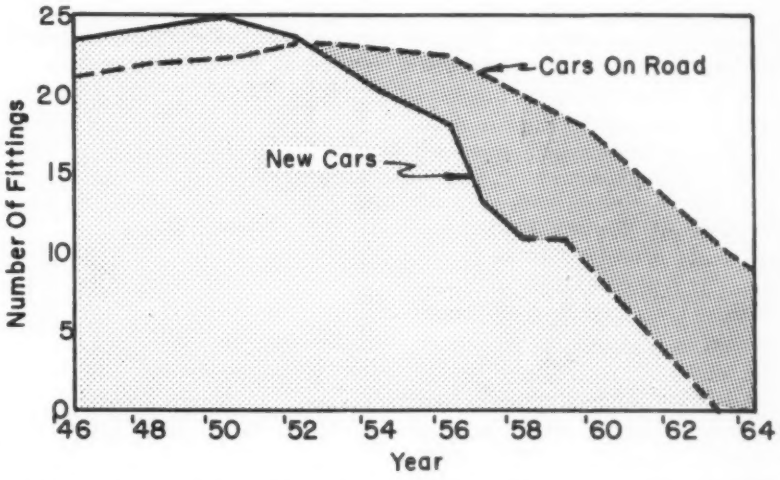


FIGURE 1—Trends in average number of grease fittings on new cars has decreased steadily since 1950.[1, 2, 3, 4]

that chassis fittings will eventually be eliminated results in a somewhat gloomy outlook for the growth potential for automotive greases. A realistic forecast, however, requires that all forces affecting demand be identified, that quantitative relationships to demand be established, and that future changes in these forces and the timing of the changes be determined. The quantitative development of these factors are presented in the following sections. However, even doubling the conservatively estimated time required to eliminate chassis fittings (from 5 to 10 years) still results in a negative growth rate for automotive grease consumption.

General Forecast Method. A forecast given in pounds per year is generally more useful to most groups than one giving growth rates. This, however, requires that precise industry automotive consumption figures be known for at least one year and preferably for several years. Unfortunately, there are no reliable and universally accepted data on grease consumed entirely in the automotive field. (It is hoped that future surveys will provide such data.) A reasonable approach to absolute levels can be made by using data from various surveys such as National Petroleum News, Check Chart, and private surveys including those made by Esso, which show the quantity of grease consumed per lubrication and the greasing interval, and other information. Each of the major factors affecting grease consumption has been analyzed on this basis, and the results and the summation of the results reviewed under the appropriate major headings are summarized in the table at the end of the report.

Number of Grease Fittings. As previously indicated, the most dramatically changing factor in the automotive grease market is the change in number of grease fittings on passenger cars.

As shown in Figure 1, the average number of fittings on new cars has decreased steadily from 1950 through 1956. In the 1957 and 1958 model cars, the number declined rather abruptly, but 1959 will apparently see a temporary leveling in the decline. It is currently estimated by some of the more optimistic automobile people that grease fittings will have disappeared from passenger cars by 1961. The more conservative indicate that this will occur by 1963. Recent advances in the field of permanently lubricated or essentially friction-free bearings make this development seem possible, and, as indicated earlier, all automobile manufacturers are working to this end.

The cost of developing and utilizing these newer friction-free or permanently lubricated bearings might be higher than anticipated. This could delay or even indefinitely postpone their use. The development of a new grease with improved properties, such as a longer interval between required greasing, might be an effective counter measure. It must be remembered, however, that there are sales advantages to the first automobile manufacturer who can claim that he has a car which does not have to be greased.

The effect of the probable decrease in fittings on grease consumption is not as immediate as it seems, since the net effect is a function of cars on the road, not new cars. In translating these data to cars on the road, we see the curve shift considerably to the right. This translation to cars on the road was accomplished by computing the actual age distribution of the total car population year-by-year for both past and future years. However, the drop will be appreciable, decreasing from an average of 21 fittings in 1957 to about 7.0 in 1965. This factor alone would tend to decrease the passenger car consumption by about 67 percent.

Even doubling the time (from 5 to 10 years) required to solve the technological problems for removal of fittings would still result in 4.8 fittings by 1965. This, however, would only increase the average number of fittings for all cars in 1965 to 10 and would still decrease passenger car grease consumption by 52 percent instead of 67 percent.

Quantity of Grease Per Lubrication. From studies conducted in 1954, it was estimated that the average consumption of grease per passenger car lubrication was 0.51 pounds, including the effect of a wheel bearing greasing at approximately 10,000 miles.

	Passenger Cars	Trucks	Buses
Esso Estimate	.51 pounds	1.04	1.10
NPN Estimate	.52		

This was almost exactly the same as the information developed by McGraw-Hill in a separate study of grease consumed in cars. For trucks and buses less information was avail-

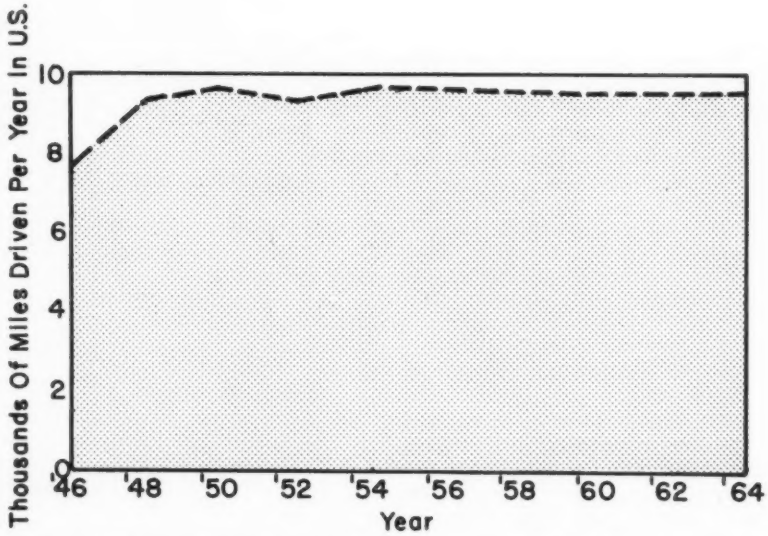


FIGURE 2—Average annual passenger car mileage appears to have become constant at about 9,000 miles per year.[4, 5, 6]

able, however, the best estimates possible show consumption to be slightly over one pound per vehicle per lubrication.

Annual Miles Driven Per Vehicle. The next factor which, when divided by the grease interval, affects grease consumption is the total annual miles driven for passenger cars, trucks and buses. Shown in Figure 2 is the trend for passenger cars—an increase since 1946, but essentially a constant level predicted from 1956 through 1965.

Esso's own estimate follows these year-to-year trends developed by the other groups very closely. However, these data could be optimistic over the next few years since the growth of two car families has been appreciable and, in this case, the total family mileage (although increased) tends to be divided between the two vehicles.

The annual miles for trucks and buses were reviewed in a similar manner. In 1956, the average miles driven for all trucks amounted to 10,800 miles annually and for buses 18,000 miles annually.

Grease Interval. The next variable to be considered was the greasing interval. A careful study of the available material revealed several interesting facts: First, while manufacturers' recommendations on passenger car chassis lubrication have remained relatively constant at about 1,000 miles, the evidence points to an interval much higher than 1,000 miles. Several studies point out that the majority (from 70-90 percent) of motorists generally grease their cars at the same time as they change oil. In effect, motorists compromise between the recommended grease interval of about 1,000 miles and an oil drain interval of about 2,500 miles recommended by some of the automobile manufacturers.

The estimated grease interval shown in Figure 3, then, is the same as the oil change interval and can be seen to be increasing steadily since the immediate post-war period.

Based on past performance, this increasing grease interval may be expected to continue upward to about 2,700 miles in 1965. The net effect of this on passenger car market for greases is to decrease that market by about 30 percent in the next ten years.

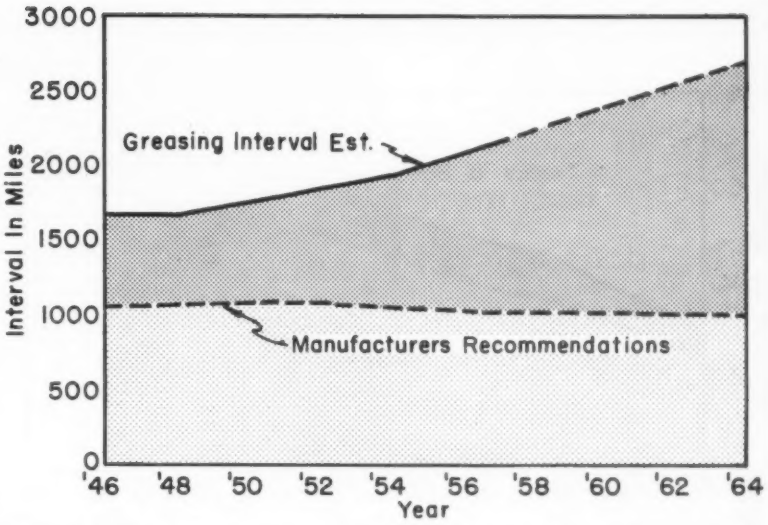


FIGURE 3—Chassis greasing interval seems to be increasing in spite of manufacturers' recommendations.[1, 4, 5, 6, 7]

For trucks and buses, indications are that the 1,000 mile interval is much more respected and projections were made on that basis. The convenience factor, so important in the passenger car market, is not present here.

Total Vehicles. The last variable affecting total consumption of grease is that of motor vehicle registrations.

As seen in Figure 4, the total number of passenger cars, trucks and buses has increased steadily since 1946 and is expected to continue in the future at a somewhat slower rate. The effect of this factor will be to increase the market by about 30 percent through 1965.

Computation of Total Market. The information above indicated that two of the four variables, namely number of fittings and grease interval, will operate to decrease the grease market in the future. The annual mileage is predicted to remain constant and only passenger car and truck registrations are predicted to influence the future grease market in a positive direction.

Based on these variables, the total annual grease requirements for chassis lubrication of cars, trucks and buses on the road have been computed. To this has been added the estimated consumption of bearing grease and the factory fill grease on new cars, trucks and buses. The total consumption of automotive greases, as computed on this basis, is shown in the cumulative plot in Figure 5. The top dotted line represents growth which could have been achieved pro-

TABLE 1—Consumption of Automotive Greases

Millions of Pounds

	1948	1950	1952	1954	1956	1958	1960	1962	1965
Passenger Cars									
Refill	81.8	102.9	108.9	117.2	114.9	101.9	87.5	61.8	35.6
Factory Fill	4.3	7.4	4.7	5.6	5.3	4.7	4.0	3.8	4.2
Sub Total	86.1	110.3	113.6	122.8	120.2	106.6	91.5	65.6	39.8
Trucks									
Refill	50.3	61.9	67.2	68.5	71.8	71.2	68.8	66.3	61.6
Factory Fill	1.3	1.3	1.0	1.0	1.1	1.0	0.9	0.8	0.6
Sub Total	51.6	63.2	68.2	69.5	72.9	72.2	69.7	67.1	62.2
Buses									
Refill	5.0	4.4	4.7	3.9	4.1	3.9	3.7	3.4	3.0
Factory Fill	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Sub Total	5.1	4.5	4.8	4.0	4.2	4.0	3.8	3.5	3.1
Grand Total	142.8	178.0	186.6	196.3	197.3	182.8	166.3	137.7	107.2

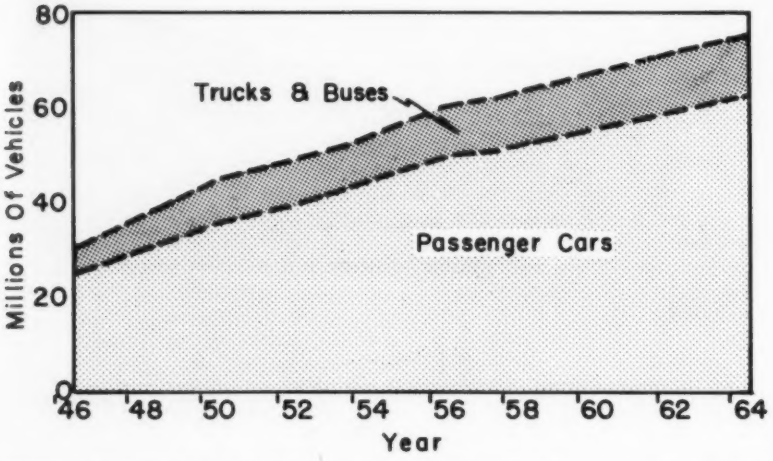


FIGURE 4—Steady increase in vehicles could account for a 30 percent increase in the grease market through 1965.[1, 2, 4, 5]

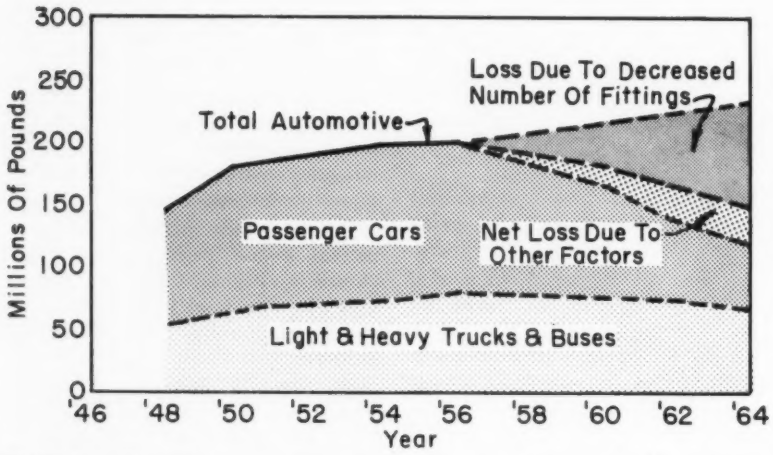


FIGURE 5—Notice the loss in grease consumption due to decreased number of fittings and other factors. [1, 2, 3, 4, 5, 6, 7, 8]

vided the indicated technological changes had not occurred.

The lowest area on the chart shows the total amount of grease consumed by trucks and buses. This market increased steadily to 1957-58 and then decreases slowly through 1965 due to the effect of a decreasing number of fittings on light trucks which have passenger car chassis. Developments in heavy truck and buses similar to those in passenger cars were not anticipated mainly due to the fact that, convenience is not as important a factor in selling trucks and buses. Thus, the truck market is not expected to decrease much more than 20 percent through 1965, this decrease coming mostly from light trucks.

The area immediately above trucks and buses, however, shows a much more dramatic decrease for passenger cars. From 1946 through 1956, the grease consumption of passenger cars increased quite rapidly and steadily. In the future, however, the market is expected to decrease from about 120 million pounds per year to approximately 39 million pounds in 1965—a decrease of 67 percent in the automotive grease market due to the factors described previously.

The effect of the decreasing number of fittings is only now beginning to be felt. This will increase as more and more cars come on the road with a smaller number of fittings, and as the older cars with more fittings are being scrapped. The crosshatch area at the top right shows the effect the decreasing number of fittings will have on the market after 1956.

The net effect of all other factors affecting grease consumption is shown in the top dotted area. This effect is minor in nature by comparison with the effect of grease fittings, but it is still substantial.

In summary, even the continued growth in automobile, truck and bus registrations does not compensate for the decline in chassis fittings and the lengthening grease interval. An improved grease to head off the inroads of the reduced number of chassis fittings or development of new markets (such as the agricultural equipment and construction equipment) seem like the only reasonable way of obtaining a positive growth rate.

Originally presented at the National Lubricating Grease Institute meeting, Chicago, Oct. 18, 1958.

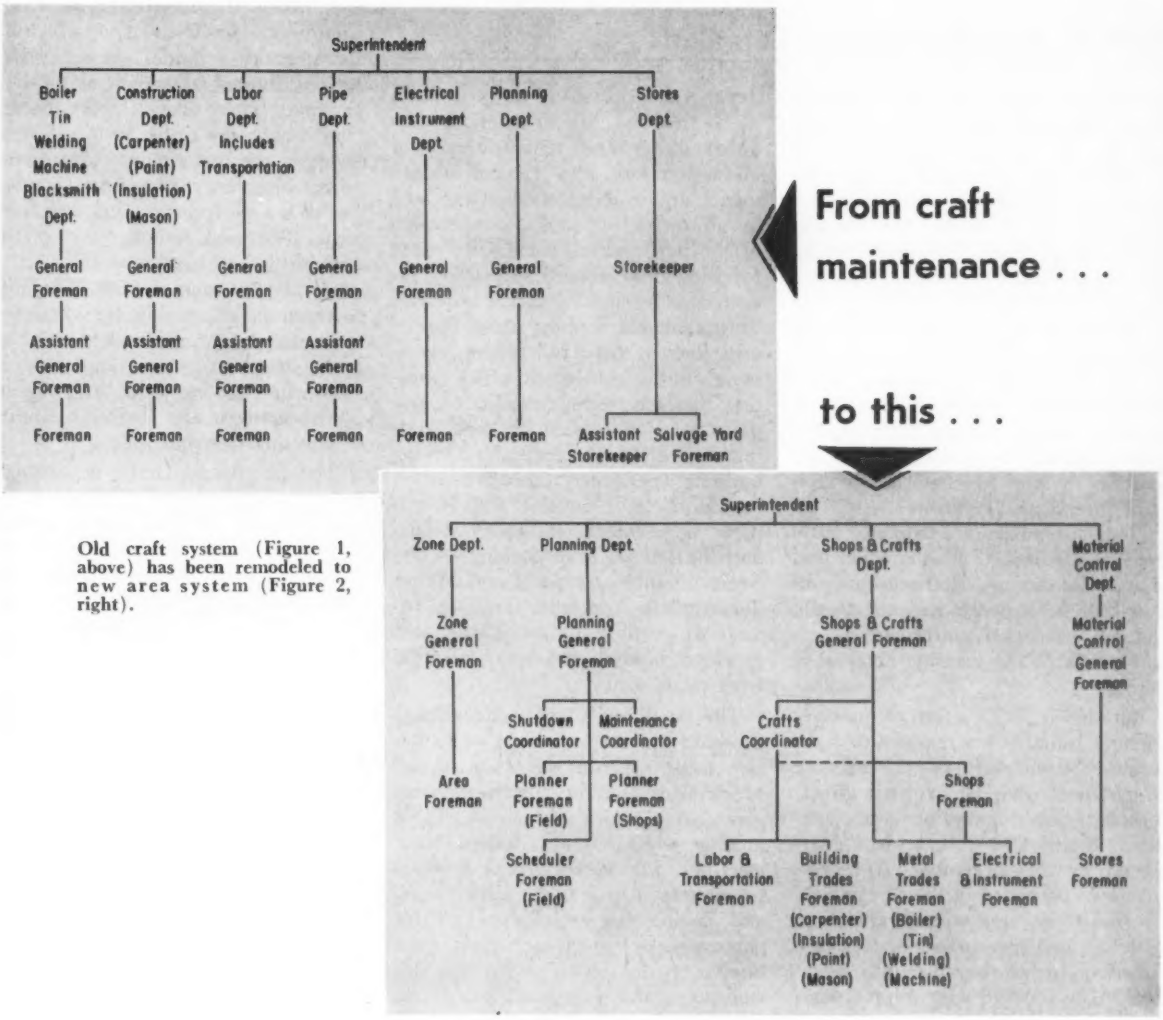
About the Authors

W. M. Drout, Jr., after receiving a B.S. degree in chemistry from Bucknell University in 1952, joined Esso Standard Oil Co., where he has gained experience through technical and supervisory responsibilities in applied research, petrochemical plant operation, and petroleum economics. He has directed economic and technical studies to improve Esso grease plant operations, and is currently head of marketing economics, which includes the direction of market potential studies. Drout is a member of several scientific societies.

N. L. Jenkins graduated from Yale University in 1951, and from Harvard University graduate school of business administration in 1956. Formerly a Naval engineering officer, he joined Esso Standard Oil Co. immediately after graduation from Harvard. Jenkins was assigned to the Economic and Research division, where he has worked in the development and analysis of market potentials and related subjects.

REFERENCES

[1] Chek-Chart Trends.
[2] R. L. Polk Register
[3] McGraw-Hill Estimate.
[4] Esso Standard Oil Company estimate.
[5] Crowell-Collier Market Studies based on personal interviews.
[6] National Petroleum News estimates.
[7] Bureau of Public Roads.
[8] Automotive Industries.



Old craft system (Figure 1, above) has been remodeled to new area system (Figure 2, right).

Shift to Area Maintenance Cuts Costs

Here's how one small refinery made a fast changeover. The results are encouraging but there are still problems

Delmer G. Debo
Standard Oil Company (Indiana)
Casper, Wyo.

AFTER OPERATING for many years under a craft type of maintenance organization, the Casper (Wyoming) refinery of Standard Oil Company (Indiana) made a fast change to the area system and the results have been very encouraging.

Maintenance costs have been reduced. Better operation with less personnel has resulted because of pinpointed supervisory responsibilities and work control procedures built into the system. Results obtained can be analyzed more accurately, and methods for improvement developed more rapidly.

But the changeover has not been without its problems. The new system requires a greater diversification of supervisory skills, as well as trained craftsmen. Training for both supervisors and craftsmen seems to be essential for optimum results.

The new system, properly staffed,

appears to offer the best organizational approach to maintenance in a refinery of some size and complexity.

The Casper refinery is a small integrated refinery manufacturing a complete line of both light oils and heavy oils products. The crude charge rate to the refinery averages approximately 18,000 barrels per day.

Under the discarded craft system, five separate craft departments headed by general foremen, as well as a Planning department headed by a general foreman, and a Stores department headed by a storekeeper, reported to the Mechanical division superintendent (Figure 1).

This organization worked fairly well. But it lacked adequate job and manpower control. Authority and responsibility for work was not clearly defined. Sufficient information was not available for accurate analysis of results.

In August, 1957, a firm of management consultants was retained to make a study principally of the existing Mechanical division organization, although other operations were surveyed briefly. The study was completed by mid-December. It recommended conversion of the Mechanical division to an area type organization, with a greatly expanded planning function. In less than a month it was decided to proceed with the reorganization.

Reorganization Preparation. Plans were made to reorganize in the shortest possible time in order to reduce the disrupting effect of a long period of waiting and uncertainty in both the supervisory and hourly roll groups. No secret was made of the fact that the company intended to proceed with reorganization. A reorganization committee, consisting of an assistant manager, the superintendent of the Mechanical Division, and a representative of the consulting engineering firm, were assigned the job of preparing for reorganization. A target date of March 3, 1958, was established for initiating the reorganization, allowing only two and one-half months for preparatory work.

The first job that the reorganization committee undertook was the preparation of a detail Procedures Manual, stating the concept of organization, detailed descriptions of all procedures to be followed, job descriptions outlining duties and responsibilities of all supervisory and clerical assignments under reorganization, as well as all forms required for operation of the new system. Plans were made for individual area headquarters for each area foreman. Existing buildings were available in most cases. Special area tools, a radio call system, necessary printing equipment, office furniture, files, etc., were requisitioned, and plans were established for consolidating some craft shop facilities. Existing buildings permitted consolidation of the Machine, Electrical and Instrument departments in one building, and the Labor, Transportation, Carpenter, Painter, Insulator and Mason departments in another building. Insofar as possible all procedures and facilities needed for reorganization were established.

The need for a good educational program was realized. Two weeks before reorganization was initiated, all Mechanical division supervisors were given their new assignments. In a number of one and one-half hour meetings, all Mechanical division supervisors, Operating supervisors, and Engineering and Research department technical personnel were briefed on the details of the new organization, and were issued procedure manuals. Additional meetings were held with each Mechanical division supervisory group to clarify responsibilities and procedural details.

One week before the operation of the new organization was started, a series of one-hour meetings were held with the hourly employes in each craft in the Mechanical division to explain the new organization. A handout describing the new organization and the procedures to be followed on the new job ticket form was issued at these meetings. Employee questions were answered. Handouts were given to operating hourly personnel, and on-the-job discussions were held with them by operating supervisors.

The New Organization. Figure 2 shows the supervisory assignments under the new organization. The plant was divided into two zones headed by zone general foremen. Each zone was divided into three relatively small maintenance areas, in which all maintenance activities are supervised by one individual known as an area foreman. Thus, all field work, except functional work to be described later, is under the direct supervision of the zone supervisory personnel, consisting of a zone foreman and area foreman. The area foreman directs the activities of all craftsmen assigned to perform maintenance work. The area foreman is responsible for obtaining materials not predetermined prior to work acceptance, and other needs that will expedite work in progress. Timekeeping is also the responsibility of the area foreman.

The Shops and Crafts department headed by a general foreman is responsible for all shop work, as well as certain types of field work called functional work which does not lend itself to the area type of supervision, either because it requires specialized skills, or because the nature of the work requires maximum mobility. Examples of functional work are special machinery overhauls, yard clean-up, janitorial services, etc. Where functional work is performed, it is under the direction of a supervisor from the Shops and Crafts department. However, particularly on special equipment repair jobs, the Shops and Crafts functional foreman may be assigned to work with and under the general direction of the area foreman. The Shops and Crafts department is also responsible for the assignment of all personnel to maintenance areas in the plant, or to shop work. It is also responsible for craft training, and for the maintenance of craft skills.

Shop and field forces have been relieved of staff functions, such as planning, scheduling, estimating, and liaison functions through the creation of a Planning department headed by a general foreman. Under the general foreman in the Planning department are three maintenance coordinators, each of whom handles two maintenance areas, as well as a shutdown coordinator. The maintenance coordinators and shutdown coordinator receive all work orders, except emergency orders, estimate manpower requirements, list material requirements, establish job priorities, and schedule sequence of work. This information is then passed on to the

Here are the advantages . . .

After 5½ months of operation, certain advantages and disadvantages of the area system of maintenance are becoming evident. No hard-and-fast conclusion can be reached after this rather short period of operation. But here are the advantages, based on limited experience:

- Supervisory responsibility has been pinpointed because of complete job supervision under one supervisor.
- Closer supervision and more contact with the men.
- Better coordination between operating and mechanical supervision on maintenance work.
- Better control of material.
- Better planning and scheduling.
- Personnel problems and the need for craft improvement training for certain craftsmen are pinpointed and should result in improved solutions at minimum cost.
- Improved morale and job interest of Mechanical division supervisors.
- Operator participation in job planning and scheduling is more active because of strict adherence to job priority system.
- Improved individual job cost reporting to operators has improved cost consciousness.
- More time is spent on job in field work because craftsmen report to area headquarters at beginning of each shift.
- All these advantages combine for a more efficient use of personnel.

and disadvantages of area maintenance . . .

The disadvantages are more difficult to evaluate. In any new system, time is required to work out problems. Since the new system was put into operation, an unanticipated increase in processing manpower requirements has resulted in operation of the Mechanical division with a reduced work force. These two factors may indicate disadvantages which are not permanent. These disadvantages are listed from present experience only:

- Area foremen are not familiar with the work of each craft, and are frequently handicapped in supervising individual items of job execution. The organization as set up provides for technical assistance from foremen in the Shops and Crafts department when such a problem occurs. However, most area foremen hesitate to avail themselves of this assistance, or in many cases cannot work it into their schedule. Special training is indicated to help solve this problem.
- Mechanics feel that they have lost their craft home, and miss the guidance and advice of more or less permanent craft foremen. Under the new system craftsmen may work under several different supervisors in any one week, and also may work in several different parts of the plant. When they have problems or questions they have a tendency to go back to their former foreman for answers rather than to discuss their problems with their currently assigned supervisor.
- Under the old system, craft locker rooms were scattered throughout the plant adjacent to craft headquarters in most cases. Under the new system craftsmen assigned to field work no longer report to their craft headquarters, and as a result a locker problem frequently occurs. A central locker room for all craftsmen at the refinery gate would help to solve this problem.
- The new system requires well-rounded craftsmen able to do all types of work in their craft. Under the old system there appears to have been a tendency to develop specialists, and as a result all craftsmen did not receive a well-rounded program of training and development. More classroom type craft development training is indicated for the new system if craft skills are to be maintained at a satisfactory level.
- The new system results in more of a supervisory replacement problem for vacations, sickness, etc.
- The new system demands better communications in the Mechanical Group and between operating and mechanical personnel. A radio paging system, in addition to a plant radio system, has been felt to be essential.

Planning general foreman and his staff. The Planning general foreman and his staff are responsible for fitting work into a schedule based upon job priority and manpower, material and equipment availability. The Planning department prepares a daily work schedule on which all jobs are scheduled, and manpower is assigned. Where completion dates cannot be met, the Planning department is responsible for initiating the necessary action for extraordinary measures to assure completion within an acceptable schedule. Other planning functions, such as those necessary to provide management with accurate information regarding backlog of work, the priority of work in backlog, and the manpower available to perform this work are delegated to the Planning department. The Planning department recommends to management long range courses of action, such as the contracting of work, manpower needs, costs, etc.

The fourth group in the new organization is the Material Control group under a general foreman which is responsible for material availability as well as the salvage function. This group was not changed under reorganization.

Thus, the new organization is divided into four basic groups: a Zone group responsible primarily for the *execution of field work;* a Shops and Crafts group responsible for the *execution of shop work, allocation of personnel,* and the *maintenance of special skills;* a Planning department responsible for the *planning and scheduling of all work;* and a Material Control group.

A description of the new organization would not be complete without special comment on the maintenance coordinator and the shutdown coordinator supervisory assignments. These supervisors, as you will note, report to the general foreman of the Planning department. They handle the advance planning for practically all maintenance work and shutdown work. They also constitute a staff group in the Planning department for special analysis and evaluation studies of all kinds under the direction of the general foreman. Only technically proficient supervisors with considerable plant operating or maintenance experience should be selected for this assignment, since they are vital to the optimum functioning of the Planning department. They can be considered as a *control group* responsible, under the direction of the Planning department, for follow-up and analysis of the operation of the system so that optimum results can be obtained.

Initial Operation. During the initial period of reorganization, timekeeping, allocation of personnel, and materials administration were the major problems. After a period of four weeks, the daily planning schedule preparation, timekeeping, and the allocation of personnel were functioning fairly smoothly. The problem of stocking adequate materials and tools and delivering them to the field to meet a close time schedule proved more difficult to straighten out.

At the present time, after about 5½ months of operation, most of the problems have been worked out. Dispatching of materials and tools have improved as experience is gained by the personnel assigned to this function. Also, establishment of stocks of frequently used small items of materials as area stores at each area headquarters has helped a great deal. Improvement has also been obtained as a result of stocking more tools in each area headquarters as area tools. The determination of additional area tools requirements was based on an analysis of tool dispatching records.

The assignment of personnel although now functioning fairly smoothly will continue to be somewhat of a problem because of almost daily fluctuation of craft work loads in each area with resultant personnel movements.

Future Development. As a result of the clean-cut assignment of job authority and responsibility of supervision with the new type organization and the functional separation of authorities and responsibilities, the system lends itself to the pinpointing of problems and to a more workable system for the assignment of items for improvement and development. As an example, the maintenance coordinator and shutdown coordinator group in the Planning department can be assigned the responsibility for and guided in the solution of improvements in job estimating, job cost analyses, equipment cost analyses, and improvements in equipment repair methods. Consideration is now being given to preparing in written form maintenance repair procedures as job guides and as training aids. This type of responsibility is usually assigned to the maintenance coordinator and shutdown coordinator personnel in the Planning department.

Improved control of preventive maintenance, particularly in the instrument and electrical work, is needed. This will be assigned principally to the Electrical and Instrument Shops and Crafts foremen.

Improvement in craft skills in the Electrical, Instrument, and Machine department is needed. Two craft foremen are being especially trained to handle craft improvement training, both in the class room and in the field, for these crafts.

More detailed craft knowledge of all craft work is needed by zone and area supervisors particularly. A special supervisory training program to assist in the rapid development of supervisors is planned.

The new system requires a rapid system of materials identification as well as an adequate supply of all materials. An engineer has been assigned to the development of a complete materials catalogue, including spare parts, in order to expedite the solution of this problem.

Originally presented at WPRA, Rocky Mountain Regional Meeting, Casper, Wyo., Sept. 24-25, 1958. ##

About the Author

Delmer G. Debo is assistant manager of the Standard Oil Co. (Ind.) Casper refinery, where he directs the Mechanical, Engineering and Utilities divisions. He has a B.S. degree in civil engineering from the University of Illinois and worked in bridge and highway construction before joining Standard of Indiana in 1937. Debo has served in the Engineering, Operating, and Mechanical divisions of the company's Whiting refinery, where he was appointed superintendent of the Mechanical division in 1952. He transferred to the Casper refinery as assistant manager in 1957.

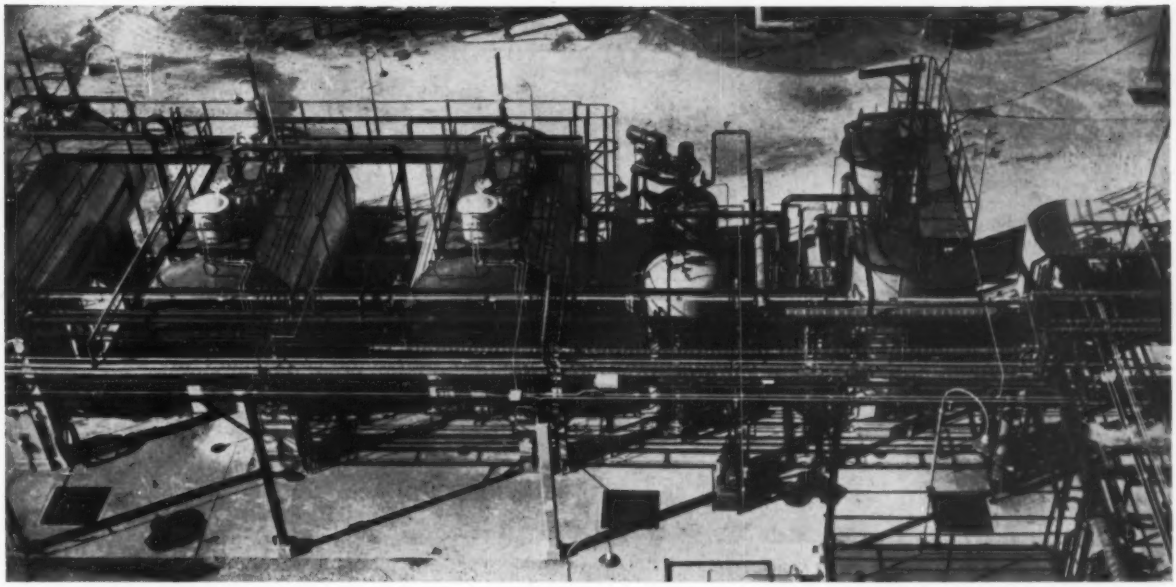


FIGURE 1—The new process uses a technique described as "electrostatic mixing" to improve the reaction efficiencies.

Sulfur Is Removed Now by New Process

The first Electrostatic Desulfurization unit is now in service at Cities Service East Chicago refinery

Robert J. Phillips and H. G. Napier
Howe-Baker Engineers, Inc., Tyler, Texas

THE FIRST commercial Electrostatic Desulfurization plant was placed in service for Cities Service Oil Company at their East Chicago refinery during October, 1958. Subsequent testing showed that the plant easily met all process requirements, with the sulfur content of the treated product averaging less than 25 ppm sulfur. The unit was similarly effective in removing arsenic. The new process employs a technique described as "electrostatic mixing" to greatly enhance reaction efficiencies.

Process Flow. Referring to the flow diagram shown as Figure 2, it is seen that the untreated hydrocarbon enters the processing system through a small mixer vessel. This vessel is equipped with turbine bladed mixers of special design. Spent alkylation acid, averaging 90 percent in strength, is added directly to the mixer vessel. The acid-hydrocarbon solution is vigorously mixed, reducing the acid particle size to a previously determined optimum diameter.

This PETROLEUM REFINER article introduced the process: "New Process for Removing Reformer Feed Stock Sulfur," Volume 35, No. 11, pages 202-204, November, 1956.

The hydrocarbon containing the acid dispersion then enters the bottom of the first electrical unit, referred to as the reaction stage. In this section, the dispersion is subjected to sufficient electrostatic mixing to insure completion of the oxidation reaction of the sulfur compounds in the hydrocarbon to the disulfide form and subsequently moving the reaction products into the acid phase. In the center portion of the reaction stage, the partially spent acid containing the reacted disulfides is continuously coalesced, collected in the bottom of the vessel, and recirculated until spent.

The hydrocarbon from the reaction stage, containnig from 20 to 75 ppm

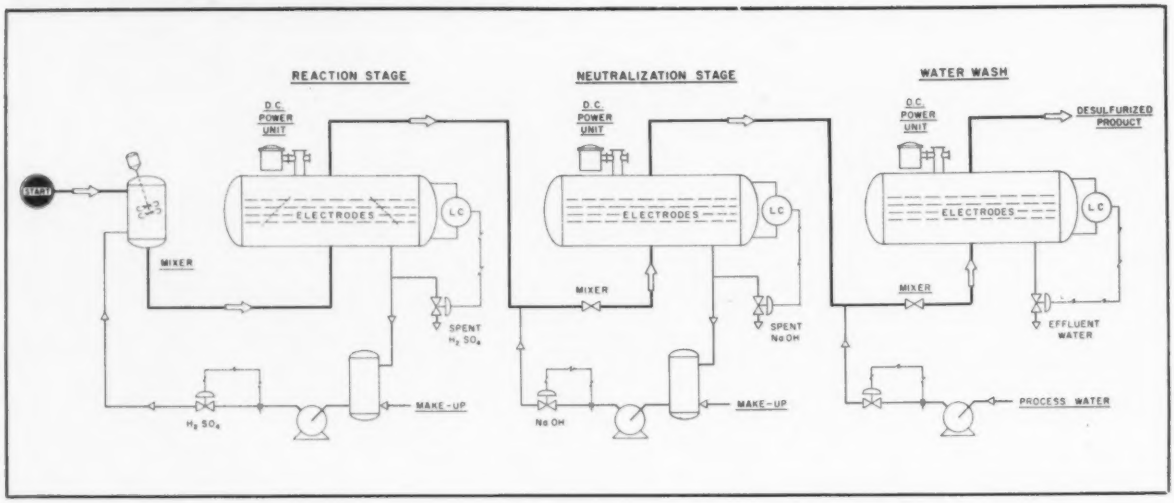


FIGURE 2—The charge and acid are mixed vigorously in a turbine blade mixer.

of suspended sulfuric acid is vigorously mixed with sodium hydroxide solution of about 10 percent concentration. This mixture is separated by electrical coalescence in the second, or neutralization stage. Carryover of suspended caustic from this section is normally zero but during periods of major changes in operations was as much as 2 ppm.

The neutralized hydrocarbon is water washed and electrically coalesced in the third unit. Any traces of suspended water are removed in the mechanical drier that represents the final unit in the processing scheme. The treated product then proceeds through a surge tank to the reforming unit.

Analysis of Operating Data. Pertinent operating data are summarized in Table 1. The Cities Service plant was designed to desulfurize 8,000 bpd. of Mid-Continent naphtha which would then be reformed in a fixed bed unit employing platinum-type catalyst. Although not a part of the performance specifications, it was expected that the concentration of trace metals such as arsenic and lead would also be substantially reduced. This proved to be correct, with essentially complete removal of arsenic. No significant quantity of lead was found in the feed stock.

Spent alkylation acid was employed since it was available to the refiner at no cost except for handling, and was completely satisfactory for the reaction. It was arbitrarily decided to recirculate the acid with the expectation that slightly better usage might be realized. It developed, however, that recirculation was not necessary to obtain maximum acid utilization, and a once-through system would have been satisfactory.

TABLE 1—Typical Operating Data

Naphtha Charge, B/D	8,000
Temperature, F	80
Reaction Stage	
Acid Circulation Rate, lbs./B	12.5
Acid mixer speed, rpm	120
Electrode power consumption, KW	1
Temperature, F	82
Insoluble acid carryover, vol %	0.002
Neutralization Stage	
Caustic circulation rate, bpd	400
Caustic mixing valve pressure drop, psi	8
Electrode power consumption, KW	1
Temperature, F	85
Suspended caustic carryover, vol %.	Nil-Trace
Water Wash	
Water injection rate, bpd	400
Water mixing valve pressure drop, psi	4
Electrode power consumption, KW.	1
Temperature, F	81
Suspended caustic carryover, vol %.	Nil
Estimated yield loss, vol %	0.4

TABLE 2—Typical Stream Inspections

NAPHTHA	Charge	Product
Gravity, API	57.2	57.2
Distillation, F		
Initial Boiling Point	185	186
10%	230	230
50%	270	270
90%	325	323
End Point	363	364
Sulfur, ppm	300	22
Arsenic, ppb	5–17	0–4.0
Chlorides, ppm	2.0	1.0
Lead, ppb	0–9.0	0–3.0
Nitrogen (total), ppm	2.0	1.0
Nitrogen (basic), ppm	Nil	Nil
Sodium ion, ppm	Nil	Nil
ACID	**Fresh**	**Spent**
Acid Strength, %	90.9	80.0

Caustic consumption was higher than expected due primarily to the necessity of neutralizing naturally-occurring organic acids, rather than any excess carryover of sulfuric acid. Net caustic consumption of less than 0.15 lbs. of NaOH per barrel of hydrocarbon resulted in operating costs of less than 0.5¢/bbl.

Operating labor requirements were very small, even during the startup period. It was found that the unit was "on-test" in about the time required for two displacements of the reaction stage, and that further operating attention was not required. All flow rates were automatically controlled and electrical energy requirements have remained unchanged. Operating labor requirements were confined to occasional observation of liquid levels and the procurement of samples for routine testing.

Typical Product Inspections. Averages analyses of the treated product over long periods of operation of the Cities Service unit are shown in Table 2. Of paramount interest, of course, is the sulfur content of the treated product. The average of nearly 200 tests, performed by four laboratories working quite independently showed an average sulfur content of the treated product of 22 ppm or 0.0022 weight percent. There were a large number of results reported as zero and the highest result reported, regardless of the circumstances, was 43 ppm.

Sulfur Is Removed Now by New Process

any case, operating costs attributable

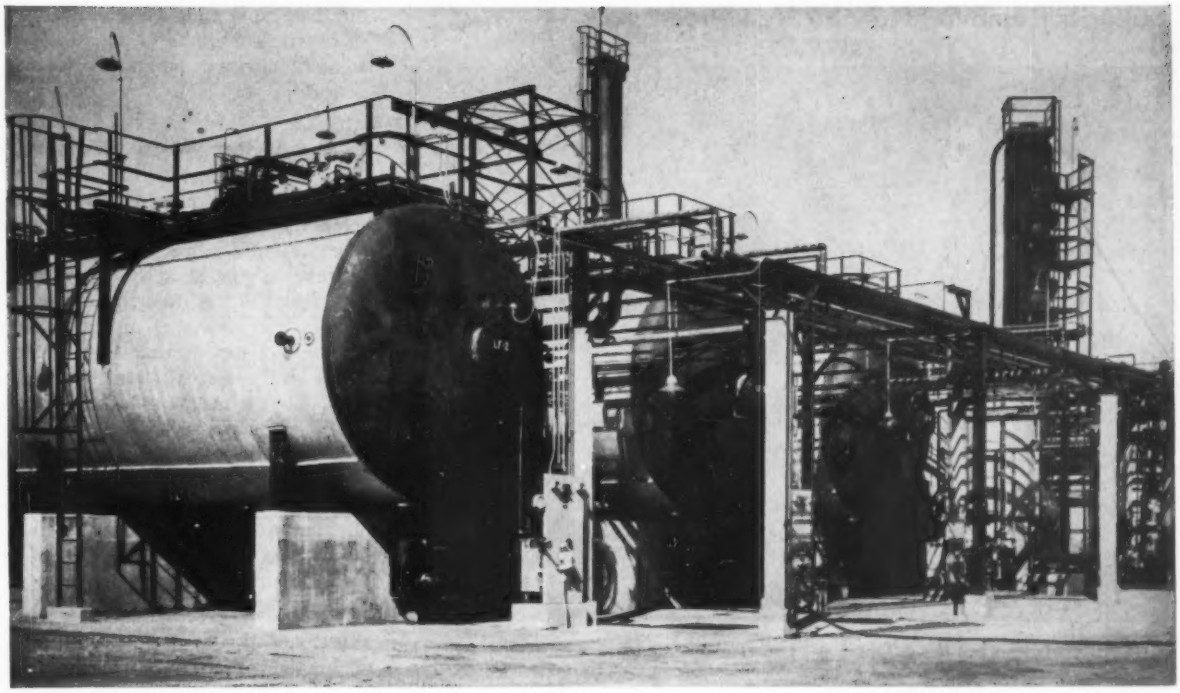


FIGURE 3—The Cities Service plant was designed to desulfurize 8,000 bpsd of Mid-Continent naphtha which would then be reformed over a platinum-type catalyst.

Analyses of the arsenic content of the feed showed a variation in concentration of 5 to 17 parts per billion. This was reduced in the treated product to 0 to 3 ppb.

Although there was very little lead in the feed stock (maximum was 9 ppb), analyses again indicated essentially complete removal to 0 to 3 ppb. The authors doubt that analyses of any of the trace metals in the 0-5 ppb range have any real significance.

Nitrogen compounds were curiously lacking in the feed stock. Both feed and product samples were analyzed by the different laboratories for both basic and total nitrogen and indicated none present. Previous work on samples rich in nitrogen confirmed that such compounds are more easily removed than sulfur. Yield losses were slightly less than 0.5 percent.

The remaining portion of this paper is devoted to an analysis of the effect of the operating variables, not only for the Cities Service unit but for other systems as well.

What Is Electrostatic Mixing?

Electrostatic mixing is a new chemical engineering technique or phenomena that may be defined as the employment of electrical energy to accelerate the motion of an electrically conductive particle or ion within the body of a non-conductive medium. In the Electrostatic Desulfurization process, the conductive particle—sulfuric acid—is reduced by mechanical mixing to a very small (and optimum) particle size with a corresponding large increase in surface area. Electrical potential is applied to carefully oriented electrodes and the electrical energy thus transmitted to the system imparts a violent and rapid motion to the dispersed particles.

Effect of Feed Stock Composition. Virgin naphthas containing as much as 3000 ppm of sulfur have been successfully desulfurized. The only major effect on operating costs is a slightly higher consumption of acid. As the boiling range of the feed stock is widened on into the middle distillate fractions, yield losses will increase since, of course, the molecular weight of the sulfur-bearing hydrocarbon has increased. Cracked stocks containing significant quantities of unsaturates may be successfully desulfurized but greater yield losses would be expected. An Electrostatic Desulfurization plant for a visbreaker gasoline is under construction and nearing completion.

Effects of Time, Temperature, and Pressure. Pressure has no effect on the completion of the oxidation reaction within the ranges conventionally employed of 25 to 200 psig. Elevated temperatures do little to improve the oxidation reaction but can cause difficulties from undersirable side reactions if allowed to exceed 140 to 150 F. For this reason, all Electrostatic Desulfurization plants are designed to operate at ambient temperatures. Reaction time is controlled to a total of from 12 to 16 minutes, depending on the nature of the feed stock.

Mechanical Mixing Is Important. External or mechanical mixing is employed solely to reduce the acid particle size to the optimum diameter necessary to achieve the desired mobility in the electrostatic field. The best acid utilization is dependent to a significant extent on achieving a uniform particle size distribution. For these reasons, unusual care has been given to the design of the mechanical mixing equipment.

Acid Type Not Critical. The reaction may be successfully completed with initial acid strengths anywhere

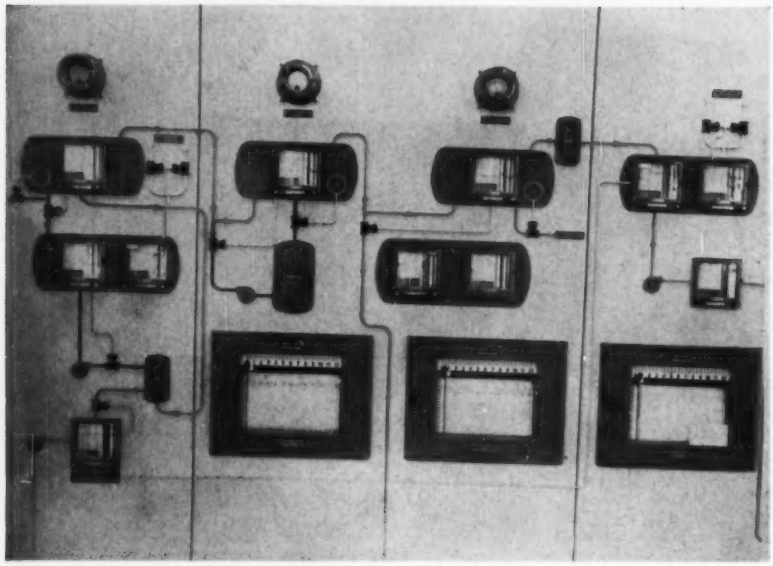


FIGURE 4—Instrument panel: Operator's attention is confined to occasional observation of liquid levels and to getting samples for routine testing.

in the range of 88 to 98 percent. The Cities Service unit employs spent alkylation acid of approximately 90 percent concentration since it is available to them at little cost. The acid strength drops from 10 to 15 percentage points with usage. The net acid consumption or dosage will, of course, vary with the composition of the feed stock. For most virgin naphthas that are to be reformed, with sulfur contents in the order of 400 to 800 ppm, acid dosages of 5 pounds per barrel of hydrocarbon are adequate.

Caustic Strength and Consumption. Caustic of almost any concentration may be used for the neutralization step. Designers usually will choose whatever strength is easily available in the refinery with preference going to the lower concentrations. The lower the strength the greater the volume of caustic that can be used to provide a given amount of free sodium hydroxide and thus minimize the contacting problem in the mixing section. It makes little difference whether the caustic is charged on a once-through or recirculated basis. The only advantage for the recirculated system is that greater injection rates are permissable without sacrifice in net consumption. In any case, operating costs attributable to caustic consumption are not likely to be of sufficient magnitude to cause concern.

Is the Water Wash Necessary? The water wash step has two functions: (1) removal of any water-soluble reaction products present in trace quantities and, (2) insurance against any operating upset upstream. It is difficult, if not impossible, to predict the frequency of upsets with any type of process unit. This process is far less "sensitive" than most processes. To the author's knowledge, no upsets of any sort have occurred in the Cities Service plant since it was placed in operation. However, no one can anticipate fully the potentiality of human error—all designers look for the worst and, if the penalties are great, insure against it.

What are the Economics? Since all engineering is reducible to dollars and cents, it is worthwhile to review briefly comparative economics. The installed cost of a 10,000 bpsd Electrostatic Desulfurization plant is on the order of $350,000 as compared with about $1 million for any conventional hydrodesulfurization unit of the same throughput. Operating costs for the new process are from one-third to one-fourth of those for hydrodesulfurization. Desulfurization and metals removal efficiency are of the same order or slightly less for Electrostatic Desulfurization. Delivery and construction time for the Electrostatic design is less than one-half of that required for hydrodesulfurization.

Status of Commercial Development. In addition to the recently completed Cities Service plant, units are now under construction for Imperial Chemical Industries and Commonwealth Oil Refining Company. Approximately 25 other plants are in one stage or another of engineering study.

ACKNOWLEDGMENT

The authors acknowledge with grateful appreciation the cooperation, assistance and encouragement of the Cities Service Oil Company —its management, engineering, operating and laboratory groups. Much credit is due Dr. Reid Robertson and his laboratory group of our parent company, National Aluminate Corporation, for their valuable assistance in performing the hundreds of necessary analyses.

About the Authors

Robert J. Phillips, inventor of the Electrostatic Desulfurization process, received his chemical engineering education at The University of Texas, where he graduated in 1948. He then joined Humble Oil & Refining Co.'s Technical Service group. In 1952, Phillips joined PETROLEUM REFINER's editorial staff, and later became editorial director. He joined Howe-Baker Engineers, Inc., in 1953 to help develop their electrostatic distillate treating processes. He became a vice president of Howe-Baker in 1957.

Harris G. Napier is chief operator for Howe-Baker Engineers, Inc. After receiving a B.S. degree in chemical engineering from Texas Technological College in 1953, he joined Gulf Oil Corp.'s technical staff at the Port Arthur refinery. He joined Howe-Baker in 1957 to assist in the operation of pilot plants. As the company's chief operator, Napier travels throughout the world to supervise the installation and startup of Howe-Baker units. He supervised the startup of a Cities Service Oil Co. desulfurization unit, and secured much of the test data used as a basis for this article.

Quick Chart for Heat Transfer Rates

Using this graphical method, shell side liquid heat transfer rates are determined quickly

Frank L. Rubin
Downington Iron Works, Downington, Penn.

HEAT TRANSFER RATES for fluids flowing across the tubes in baffled heat exchangers can be determined by the Donohue[1] equation—

$$\frac{hD}{k} = 0.22 \left(\frac{D\,G_e}{\mu}\right)^{0.6} \left(\frac{c\mu}{k}\right)^{1/3} \left(\frac{\mu}{\mu_w}\right)^{0.14} \qquad (1)$$

With the use of the more conventional engineering units—viscosity in centipoises, diameter in inches, and mass velocity in pounds per second per square foot—the equation changes to the form:

$$h = 11.55 \frac{G_e'^{0.6}\, k^{2/3}\, c^{1/3}}{d^{0.4}\, \mu_e^{0.27}} \left(\frac{\mu_e}{\mu_{cw}}\right)^{0.14} \qquad (2)$$

A design chart has been prepared for ¾-inch O.D. tubes arranged on a $1\frac{5}{16}$-inch triangular pitch with specific heat of the fluid at 0.50 and thermal conductivity of 0.075. Factors for other tube diameters and pitches are shown. Correction factors for other values of specific heat and thermal conductivity can be determined from the inserted curves. This chart is similar to one for gases published in the March, 1957, issue of PETROLEUM REFINER.[2]

Sample Calculations. 1. Given: Carbon tetrachloride at 250 F. is flowing on the shell side of a baffled heat exchanger with ¾-inch O.D. tubes on a square pitch. Mass velocity is 30 lb./(sec.) (sq. ft.).

$G_e' = 30.$
$\mu_e = 0.3$ centipoise
tube factor = 0.88
$k = 0.044$ $\quad k_{factor} = 0.70$
$c = 0.24$ $\quad c_{factor} = 0.77$

$$h = 125 \times 0.88 \times 0.70 \times 0.77 = 60$$

2. Given: 40,000 pounds per hour of 25 percent calcium chloride brine at 30 F. are flowing in a fixed tube sheet heat exchanger. Shell size—24-inch pipe, ⅜-inch wall. Segmental baffles are spaced on a 6-inch pitch with a 20 percent net free area cut. 1″ diameter tubes on a $1\frac{1}{4}$″ triangular pitch are arranged for a single pass tube side.

$$\text{cross flow clearance}^3 = 5.25 \text{ inches}$$

$$G_e' = \frac{40{,}000}{6 \times 5.25 \times 25} = 50.7 \text{ lb./sec.-sq. ft.}$$

(**Note:** 3600/144 = 25. This conversion factor permits the direct use of pounds per hour for flow, and inches for both baffle pitch and clearance between tubes, to give an end result of mass velocity in convenient engineering units.)

Cross-sectional pipe area = $(23.25)^2 \times 0.786 = 425$ sq. in.
Area of tubes = $268 \times (1)^2 \times 0.786 = 211$ sq. in.
Net free area = 214 sq. in.

(**Note:** The tube count of 268 has been taken from the tube count tables of the Downingtown Iron Works. These are available upon request to the company.)

$$G_b' = \frac{40{,}000}{0.20 \times 214 \times 25} = 37.4 \text{ lb./sec.-sq. ft.}$$

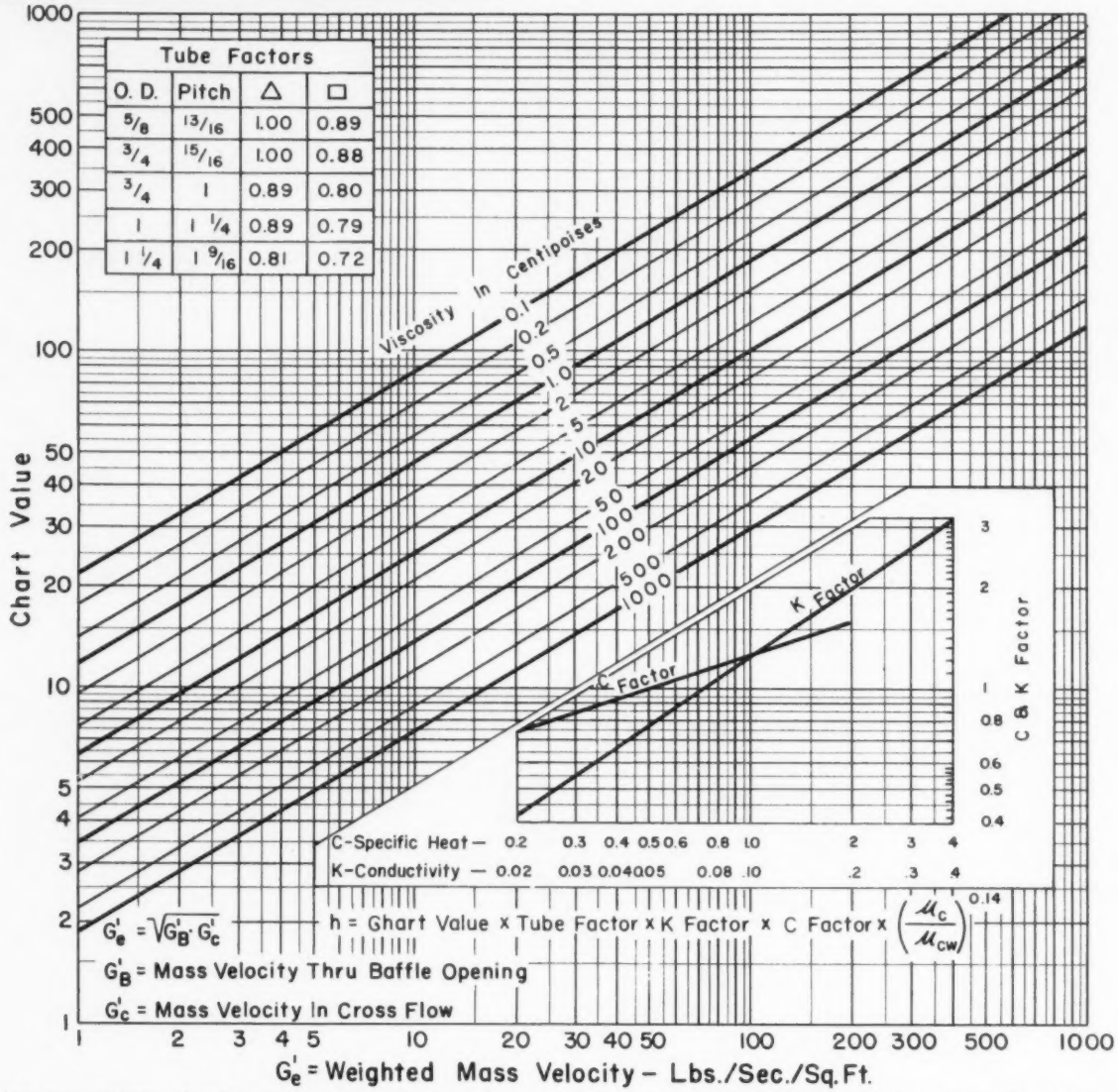
$$G_e' = \sqrt{G_b' \cdot G_c'} = \sqrt{50.7 \times 37.4} = 43.5$$

$\mu = 5.2$ centipoises
tube factor = 0.89
$k = 0.285$ $\quad k_{factor} = 2.5$
$c = 0.67$ $\quad c_{factor} = 1.1$

$$h = 73 \times 0.89 \times 2.5 \times 1.1 = 179$$

The viscosity ratio correction factor $\left(\frac{\mu_e}{\mu_{cw}}\right)^{0.14}$ has been assumed to equal one in the sample calculations.

Quick Chart for Heat Transfer Rates . . .


Tube Factors
O. D. | Pitch | △ | □
5/8 | 13/16 | 1.00 | 0.89
3/4 | 15/16 | 1.00 | 0.88
3/4 | 1 | 0.89 | 0.80
1 | 1 1/4 | 0.89 | 0.79
1 1/4 | 1 9/16 | 0.81 | 0.72
Viscosity In Centipoises
0.1
0.2
0.5
1.0
2
5
10
20
50
100
200
500
1000
K Factor
C Factor
C & K Factor
C-Specific Heat — 0.2 0.3 0.4 0.5 0.6 0.8 1.0 2 3 4
K-Conductivity — 0.02 0.03 0.04 0.05 0.08 .10 .2 .3 .4
0.14
Chart Value
$G_e' = \sqrt{G_B' \cdot G_c'}$
h = Ghart Value x Tube Factor x K Factor x C Factor x $\left(\frac{\mu_c}{\mu_{cw}}\right)$
G_B' = Mass Velocity Thru Baffle Opening
G_c' = Mass Velocity In Cross Flow
G_e' = Weighted Mass Velocity – Lbs./Sec./Sq.Ft.

Using mass velocity, viscosity, specific heat and thermal conductivity, this chart gives tube, specific heat and thermal conductivity factors along with a chart factor for finding heat transfer rates for shell side liquids.

About the Author

Frank L. Rubin has a 16-year background in the chemical, petrochemical and petroleum industries. Most of that time has been spent in the testing of heat transfer equipment. Now with Downington Iron Works, he has been a senior job engineer on AEC projects, chemical plants, and refineries while with Catalytic Construction Co. He has also been with The Lummus Co. in the Heat Exchanger division, and with Stauffer Chemical Co. in the Research division. Rubin has a B. A. degree from Brooklyn College, a B. S. degree in chemical engineering from Cooper Union School of Engineering, and has completed graduate work at the Polytechnic Institute of Brooklyn. He is a member of ASME and AICHE.

NOMENCLATURE

- c = Specific heat at constant pressure—BTU/lb. F.
- D = Equivalent diameter for heat transfer—feet
- d = Equivalent diameter for heat transfer—inches
- G = Mass velocity—lb./(hr.) (sq. ft.)
- G' = Mass velocity—lb./(sec.) (sq. ft.)
- G_e = Weighted shell side mass velocity = $(G_c\, G_b)^{0.5}$—lb./(hr.) (sq. ft.)
- G_e' = Weighted shell side mass velocity—lb./(sec.) (sq. ft.)
- G_c = Cross flow mass velocity—lb./(hr.) (sq. ft.)
- G_c' = Cross flow mass velocity—lb./(sec.) (sq. ft.)
- G_b = Mass velocity through baffle opening—lb./(hr.) (sq. ft.)
- G_b' = Mass velocity through baffle opening—lb./(sec.) (sq. ft.)
- h = Coefficient of heat transfer at outer tube surface—BTU/(hr.) (sq. ft.) (F.)
- k = Thermal conductivity—BTU/(hr.) (sq. ft.) (F.)/ft.
- μ = Viscosity at average fluid temperature—lb./(hr.) (sq.ft.)
- μ_c = Viscosity at average fluid temperature—centipoises
- μ_w = Viscosity at tube wall temperature—lb./(hr.) (sq. ft.)
- μ_{cw} = Viscosity at tube wall temperature—centipoises

LITERATURE CITED

[1] Donohue, D. A. *Ind. Eng. Chem.*, **41**, 2499-2510 (1949).
[2] Rubin, F. L. Petroleum Refiner, **36**, 226-228, March (1957).
[3] Rubin, F. L. *Chemical Engineering*, **64**, 257-260, Feb. (1957).

Heat Transfer Nomographs

Part 4—Prandtl numbers for liquids and gases

Part 5—Nusselt numbers for liquids and gases

Part 6—Internal heat transfer for Reynolds numbers larger than 10,000

Jose Alvarez C. and Carlos Duhne
Instituto de Investigaciones Industriales
Instituto Tecnologico de Monterrey
Monterrey, Mexico

FILM COEFFICIENTS, as a function of Nusselt numbers, appear in most heat transfer equations. The nomographs included here permit the rapid determination of transfer coefficients and/or Nusselt numbers.

Nusselt Numbers for Liquids—Nomograph No. 11 is designed to indicate the coefficient of h, or the group $h\left(\frac{\mu_s}{\mu}\right)^{0.14}$, when the values of the Nusselt number, or $Nu\left(\frac{\mu_s}{\mu}\right)^{0.14}$, is known. Nusselt numbers are found for several different cases in nomographs 13, 16, 17, etc.

The nomograph solves the formulas:

$$Nu = \frac{hD'}{12\,k}$$

$$Nu\left(\frac{\mu_s}{\mu}\right)^{0.14} = \frac{hD'}{12\,k}\left(\frac{\mu_s}{\mu}\right)^{0.14}$$

Where: Nu, Nusselt number
h, Film coefficients, Btu/h. sq. ft. F.
k, Conductivity, Btu/h. ft. F.
D', Inside diameter, inches
μ_s, Viscosity of the fluid at the temperature of the surface, centipoises
μ, Bulk viscosity of the fluid, centipoises

Example: Find the film coefficient

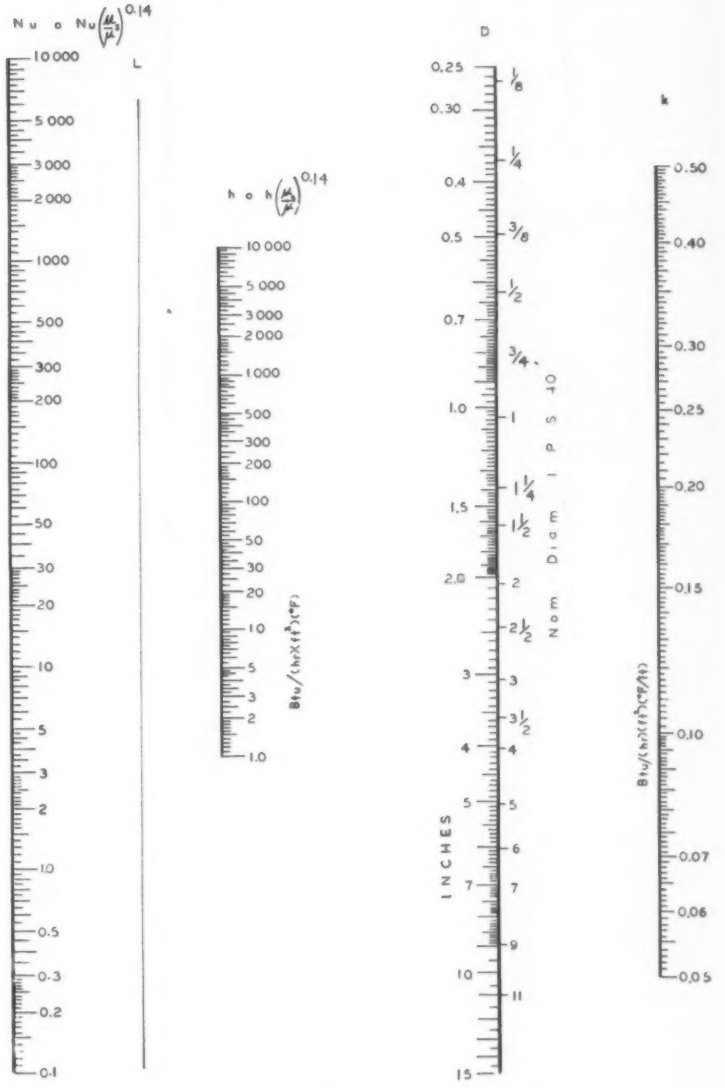


FIGURE 11—Nusselt number for liquids.

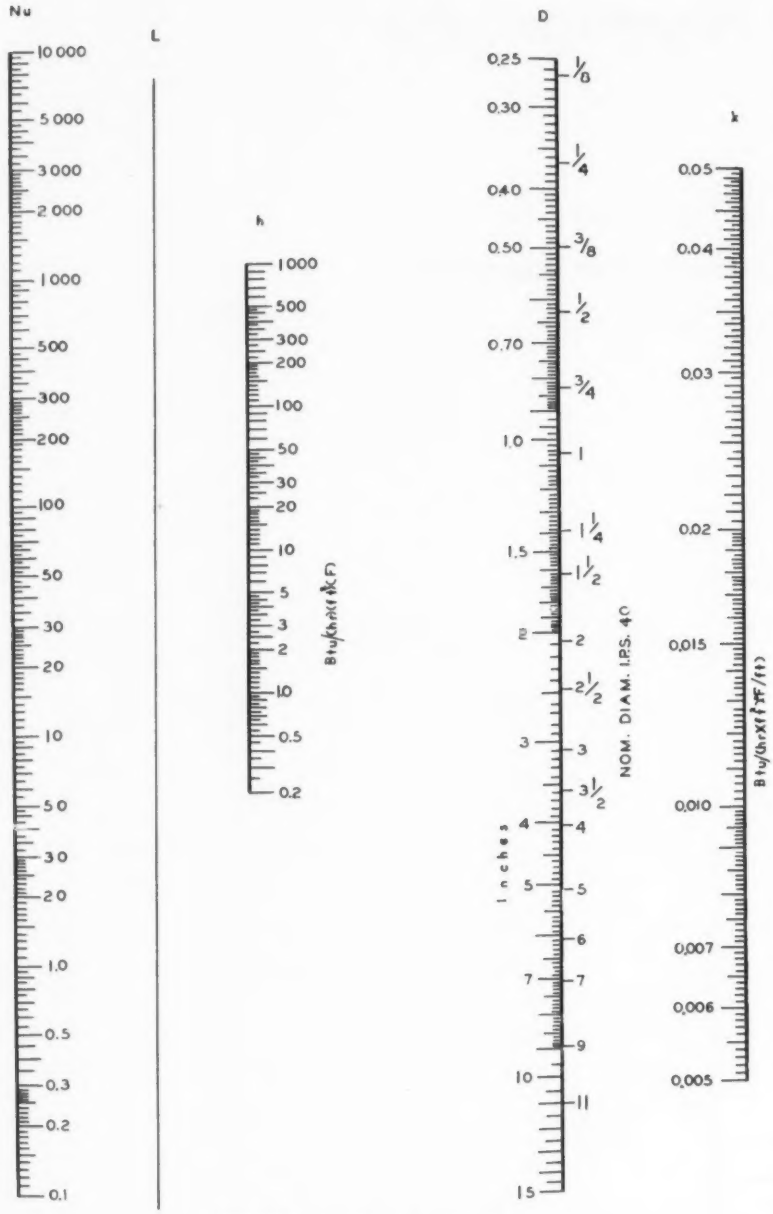


FIGURE 12—Nusselt number for gases.

"h" for water at 100 F. flowing through 1 inch Std. (I.P.S. 40) pipe. Nusselt number was found to be 100. Thermal conductivity 0.36 Btu/h. ft. F.

Solution: Using Nomograph No. 11 the film coefficient is found to be 430 Btu/h. sq. ft. F.

$$\text{Key : Nu or Nu}\left(\frac{\mu_s}{\mu}\right)^{0.14}\text{ D : L}$$

$$\text{L — k : h or h}\left(\frac{\mu_s}{\mu}\right)^{0.14}$$

Nusselt Numbers for Gases—Nomograph No. 12 is designed to indicate the coefficient h, or the group $h\left(\frac{\mu_s}{\mu}\right)^{0.14}$, when the values of the Nusselt number, or $Nu\left(\frac{\mu_s}{\mu}\right)^{0.14}$, are known. Nusselt numbers are given for several different cases in Nomographs 16, 17, etc.

The nomograph solves the formulas:

$$Nu = \frac{hD'}{12\,k} \text{ and}$$

$$Nu\left(\frac{\mu_s}{\mu}\right)^{0.14} = \frac{D'}{12\,k}\, h\left(\frac{\mu_s}{\mu}\right)^{0.14}$$

Where: Nu, Nusselt number
h, Film coefficients, Btu/h. sq. ft. F.
k, Conductivity, Btu/h. ft. F.
D', Inside diameter, inches
μ_s, Viscosity of the fluid at the temperature of the surface, centipoises
μ, Bulk viscosity of the fluid, centipoises

Example: Find the value of the film coefficient for a gas flowing in a 1 inch Std. (I.P.S. 40) pipe if the Nusselt previously found was 10. Thermal conductivity of the gas is 0.036 Btu/h. ft. F.

Solution: Using Nomograph No. 12, the film coefficient is found to be 4.3 Btu/h. sq. ft. F.

$$\text{Key : Nu or Nu}\left(\frac{\mu_s}{\mu}\right)^{0.14}\text{ D : L}$$

$$\text{L — k : h or h}\left(\frac{\mu_s}{\mu}\right)^{0.14}$$

TO BE CONTINUED

Know Your Insulations

To specify the right insulation for your job, you need to know the basic differences between various types. Here's a roundup of the generic varieties, their limits and their range of usefulness

Don Armstrong
The Aber Company, Incorporated, Houston

THERE ARE so many styles and trade names of insulations on today's industrial market that one easily becomes confused concerning their differences and their similarities.

Most modern day insulations can be grouped into one of the following categories:

1. Fibrous asbestos
2. Calcium silicate
3. 85 percent magnesia
4. Fibrous glass
5. Fine spun glass
6. Mineral wool
7. Cellular glass
8. Vegetable cork
9. Expanded polystyrene

This grouping purposely omits many one time insulation favorites that no longer make up an appreciable segment of the industrial insulation market. It also omits such specialty types of insulations as the metal reflective insulations, polyurathenes, the isocynates, etc., which still find themselves in somewhat limited specialty use.

There is no denying that there are often appreciable differences in the quality of insulations from one manufacturer to another even though they fall within the same category and even follow similar manufacturing processes. However, since we are concerned here more with the rule than the exception, the following generalizations about each category are realistic:

1. Fibrous Asbestos. This type of insulation is rolled to thickness on mandrels, using liquid silicate as a binder for extra long African amosite fibers. It is force dried under heat, trimmed and sliced into two sections. Under current manufacturing techniques, it has a smooth silicate shell surface. It is available in pipe insulation and block insulation forms and is manufactured to dimensional standard thickness.

It is basically serviceable up to 750 F. temperature, but with the manufacturing addition of diatomaceous earth, the temperature limit is extended to a full 1200 F. It has a basic density of 12 to 14 pounds per cubic foot (excluding its shell), a "K" factor of approximately .37 at 200 F. mean temperature and is noted for its extreme ruggedness. It can be thrown against hard surfaces with relatively litle damage, will withstand considerable foot traffic and various other forms of physical abuse.

Fibrous Asbestos soaks up water readily, but dries out again with relatively little damage to the material. It can be removed and replaced many times even after long periods of installation.

This material is especially adaptable to the fabrication of prefabricated fittings, for bridging flanges and flange valves and for other applications where above average strength is a prerequisite.

Until recent manufacturing techniques were adapted, some complaints arose from field workmen concerning asbestos "stickers" getting in the hands; however, this problem has now been overcome to a very large extent. Fibrous asbestos is susceptible to practically no shrinkage, has excellent "hinge" effect, is generally considered a high temperature insulation for temperatures in excess of 200 F., has a sufficiently spongy characteristic that "gives" with shock rather than cracks or breaks. It is competitively priced to other high temperature insulations.

2. Calcium Silicate. This insulation is manufactured by both extruded and molded processes, is available in both pipe and block insulation in dimensional standard thicknesses, has an approximate "K" factor of .35 at 200 F. mean temperature, a density of 12 pounds per cubic foot, temperature limitations of 1,200 F. It is powdery to the touch and is therefore well accepted by applicators.

Calcium silicate is a rigid type of insulation and although reasonably strong, will fracture and break on impact. It absorbs water, but dries out to its original state.

It can be used for prefabricated fittings, but some difficulty is experienced in sticking the segments together because of its powdery surface. It occasionally evidences considerable shrinking characteristics. It is competitively priced with other high temperature insulations.

3. 85 Percent Magnesia. This insulation is one of the "originals" of the industry and is still preferred by many of the industry's pioneers. It is manufactured from magnesia, with some fiber binding, by molded processes. It has published "K" factors that vary from .37 to .45 at 200 F. mean, a density of 12 pounds per cubic foot, and a temperature limit of 450-550 F.

Magnesia is extremely powdery to the touch and therefore a favorite of many applicators. It absorbs water and moisture readily and tends to "paste" and disintegrate from prolonged moisture exposure. It is a rigid type of composition, notably lacking in strength and therefore easy to fracture and break. Its price is competitive to other high temperature insulations.

4. Fibrous Glass. A very rugged pipe insulation composed of glass fibers with a plastic binder, "K" factor of .28 at 200 F., density approximately 6 pounds per cubic foot and a very resilient material that is not susceptible to breakage. Generally irritating to hands and body because of the glass fibers and disliked by many applicators, its temperature limits are approximately 350-450 F. It is competitive in price to other high temperature insulations.

Know Your Insulations . . .

5. Superfine Fibrous Glass. This insulation has most of the characteristics of regular fibrous glass, except that it is composed of a more finely drawn glass fiber and is appreciably less irritating to the skin. It is generally recommended for a somewhat lower temperature limit of around 400 F. and is available in what is termed a "snap-on" style for pipe insulation.

This style of insulation is considered to install faster than insulation in two separate sections. There is, however, some applicator resistance against it in some areas for this reason.

The "K" factor is accepted to be around .25 at 200 F. mean.

Its price is competitive to other high temperature insulations, except that it is also available in ½-inch and ¾-inch thicknesses which other categories of insulations are not, giving it an appreciable material cost advantage in these areas.

6. Mineral Wool Insulations are available in a wide variety of forms: rigid block, blanket, felt, insulating cement, and pipe insulation.

The insulating characteristics of mineral wool vary considerably dependent on its form.

Rigid Block has a temperature limit of 1,700 F., a "K" factor of .35 at 200 F. mean temperature and a density of 15 lbs. cubic foot. It is priced somewhat below other forms of high temperature block, is very easy to cut and apply, and conforms well to surface irregularities. But it does tend toward fragility, breakage, and deterioration.

Blanket has a temperature limit of 1,200 F., a "K" factor of .35 at 200 F., and a density varying from 3 to 8 lbs. per cubic foot dependent on the fabricator. Although price per board foot is not proportionate, it is generally priced considerably below high temperature blocks especially in greater thicknesses. Blankets are available in wide variety of metal fabric encasements including wire mesh, stucco lath, expanded and rib lath.

Fairly simple to apply, blankets tend to severe compression at points of securement which must be filled out flush with cements or otherwise. In use, blankets hold up reasonably well —far better than their metal fabrics which often rust out in short periods.

Perhaps the biggest objections to blanket are its tendency to "settle" and the wide quality variance between those offered on the market.

Many unfavorable characteristics of blankets have been overcome in recent years by several manufacturers who have adopted a new "spun wool" process.

Insulation Cements are available in dry bag form and must be mixed with water and applied by troweling as a secondary insulation or a monolithic insulation. They are generally available in a "slow set" type and a fast "hydraulic set" type.

Hydraulic set types have a maximum temperature recommendation of approximately 1,200 F., a "K" factor of .70 at 200 F. mean, a dry coverage of 110 sq. ft., ¼ in. thick/100 lbs., and practically no shrinkage.

Slow set types have temperature limits of 1,800 F., "K" factor of .55 at 200 F. mean, a dry coverage of 180 sq. ft., ¼ in. thick/100 lbs. (Wet coverage: 200 sq. ft.), and a shrinkage of 10-15 percent.

The primary advantages of hydraulic set over slow set cements are that hydraulic set types can be applied in greater single application thicknesses, don't shrink and crack, act as a combination finishing cement and insulation cement, drying out with a smooth surface and are relatively unaffected by rain that sometimes occurs before the weatherproofing plastic is applied.

7. Cellular Glass Insulation. A rigid type of insulation manufactured from glass and other chemicals, it is black in color and consists of hermetically sealed individual dead air bubbles or cells. Generally considered to be a low temperature type of insulation, but temperature recommendations range from —350 F. to +800 F.

The "K" factor is .38 at 50 F. mean temperature. It will not absorb water except on its surface, will not burn or support combustion, cuts easily, but is very abrasive to cutting tools.

Its density is 9 pounds per cubic foot. It is available in flat blocks, lags, curved sidewall segments, pipe insulation, and fitting insulation.

Because of its glasslike rigidity, it is susceptible to thermal shock at higher temperature ranges when temperature change exceeds 125 F. per hour. Because of its abrasive nature, it will abrade against itself and should be protected where necessary. The material does not absorb water is completely vapor proof therefore highly adaptable as a low temperature insulation since it does not have to rely on a mastic or other type of finish to give it vapor seal protection on low temperature application. It is competitive in price to other low temperature types of insulations, and considerably less expensive than other high temperature block insulations.

8. Vegetable Cork. This insulation is manufactured from natural cork bonded together under pressure with the cork resin as binder. It is considered a low temperature type of insulation.

The "K" factor is .28 at 50 F. mean, density 8 pounds per cubic foot. A porous type of insulation, it is totally dependent on a mastic finish for vapor seal and moisture protection. It will burn and smolder but will normally not support combustion.

Cork is a very resilient type of material and therefore not susceptible to appreciable breakage. It is available in block, pipe insulation, and pipe fitting forms. Its minimum temperature limits are dependent entirely on the efficiency of the vapor seal finish. It cuts easily with a saw or a knife. Soft to the touch, it is well accepted by applicators. It absorbs moisture readily and is competitively priced to other forms of low temperature insulations.

9. Expanded Polystyrene. A low temperature pipe, fitting and vessel type insulation available in two types: Self extinguishing (temperature limits +155 F.) and non-self extinguishing (temperature limit +175 F.). It is extremely light in weight (density from 1.1 to 2.3 lb./cu. ft.), "K" factor .25 at 40 F. mean, very low moisture absorption and a compression strength of 1,750 to 3,000 lb./sq. ft.

Polystyrene is pleasant to handle, it cuts easily with knife or saw, it is odorless, nondusting, nonflaking, does not delaminate and has a very low breakage.

Perhaps the prime disadvantage with polystyrene is its extreme susceptibility to deterioration from both heat and a wide variety of solvents.

In the nonself-extinguishing type, polystyrene will support fire.

Polystyrene is priced somewhat lower than other types of low temperature insulations.

ACKNOWLEDGMENT

This article is an excerpt from a more comprehensive work by the author entitled "Fundamentals of Industrial Insulation."

For Condensed Cyclic Aromatics . . .

Predict Hydrogenation Aromatics

Here's a simple method to estimate the hydrogenation equilibria which Shell Development uses with good results

A. Bondi
Shell Development Company,
Emeryville, California

A RECENT CALCULATION by Myazawa and Pitzer[14] has confirmed a very simple method for the rough estimation of hydrogenation equilibria which has been in use at this laboratory for some time. It might therefore be of use also for others.

The Heat of Hydrogenation. The heats of formation of condensed cyclic naphthenes are rarely available, and can hardly be predicted with any degree of reliability. Recourse is had, therefore, to the effect of resonance stabilization on the heat of hydrogenation (ΔH_h) of unsaturated compounds, first discussed by Kistiakowsky, Vaughn et al.[10] According to this rule

$$\Delta H_h = u \cdot \Delta H_h^* - E_R$$

where u = number of double bonds to be saturated per aromatic molecule, ΔH_h^* = heat of hydrogenation per olefinic double bond of reference olefin, and E_R = resonance energy of the aromatic molecule. Care must only be taken that a consistent choice of ΔH_h^* and E_R is made. If that is done, rather good predictions of ΔH_h are possible, as is shown by the data of Table 1. A series of frequently used heats of hydrogenation is presented on Table 2.

Thermodynamic Property Changes. The assumption was made that the change in free energy function $\delta_h(f) = [(F^\circ - H_o^\circ/T)$ (cyclo-

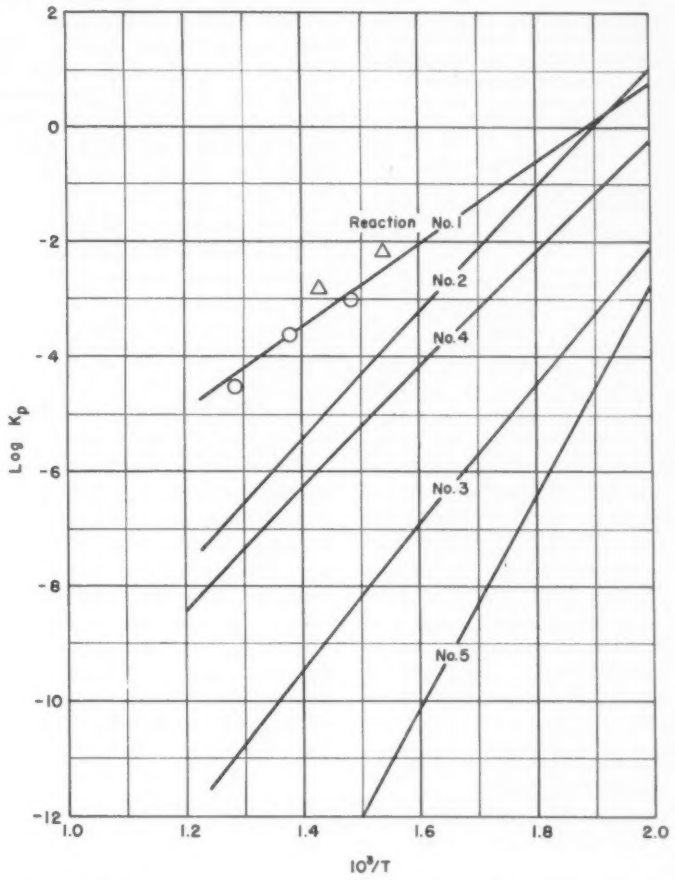


FIGURE 1—Plot of calculated equilibrium constants (K_p) versus temperature. (Calculated from data of Fetterly,[6] shown as Δ, and Hall,[9] shown as 0.)

LEGEND

Reaction 1. Napthalene + $2H_2 \rightleftharpoons$ Tetralin
Reaction 2. Tetralin + $3H_2 \rightleftharpoons$ Decalin
Reaction 3. Phenanthrene + $4H_2 \rightleftharpoons$ Sym-Octahydrophenanthrene
Reaction 4. Sym-Octahydrophenanthrene + $3H_2 \rightleftharpoons$ Perhydrophenanthrene
Reaction 5. Chrysene + $6H_2 \rightleftharpoons$ Dodecahydrochrysene

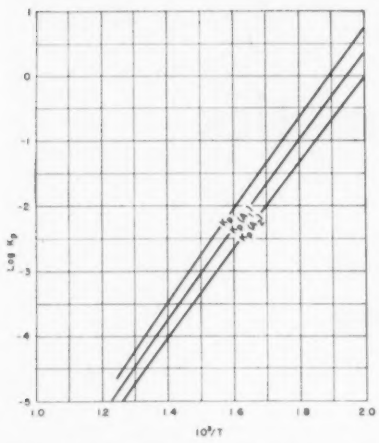


FIGURE 2—Comparison of the equilibrium constants for the hydrogenation of naphthalenes to tetraline as a function of alkyl chain content and temperature.

paraffin) — ($F^o - H_o^o/T$) (aromatic hydrocarbon)] upon hydrogenation of a condensed cyclic aromatic hydrocarbon should be simply

$$\delta_h(f) = \delta_h^*(f) + \frac{2}{3}(m-1)\,\delta_h'(f)$$

where m = number of rings per molecule, $\delta_h^*(f)$ = average free energy function difference between alkylbenzenes and the corresponding alkyl cyclohexane (its more stable isomer), and $\delta_h'(f) = \delta_h(f)$ for the reaction o-xylene → to 1, 2-dimethylcyclohexane. The values of $\delta_h^*(f)$ and $\delta_h'(f)$ are given on Table 3. The rather good agreement between the predictions from this simple scheme and the results of more accurate calculations for hydrogenation of naphthalene to tetralin and decalin are shown in Table 4.

A similar calculation of the change in heat content $\delta_h(h)$ yields for $\delta_h(h)$ naphthalene → decalin at 25° C 1.5 kcal/mole compared with 1.3 kcal/mole by Pitzer's calculation. Using Pitzer's and Szekely's calculations as a basis, a set of recommended $\delta_h(f)$ and $\delta_h(h)$ increments is presented as Table 5.

Hydrogenation Equilibria. The equilibria calculated with the aid of Tables 1 and 3 are shown on Figure 1. The agreement with the few very crude experimental naphthalene-tetralin equilibria[6,9] is tolerably good. Poisoning of the catalyst by naphthalene apparently prevents successful equilibration with decalin.[7,9] The amazing agreement between the results of the crude equilibrium calculation for the naphthalene-decalin hydrogenation and those of Pitzer's more accurate method on Table 6 is partly due to a fortuitous compensation effect that can be readily detected by inspection of Tables 1 and 4. But even the limits of ΔH_h and of the increments would have yielded quite satisfactory results, demonstrating the power of this very simple method.

The effect of side chains on the hydrogenation equilibria should be significant and can be estimated with a few plausible assumptions. The effect of side chains $\delta_a(\Delta H_h^o)$ on the heat of hydrogenation of benzene, determined by Kistiakowsky et al.[10] is assumed to prevail also in polynuclear aromatics. The effect of side chains on the thermodynamic property increments is taken as equal to that for the corresponding alkylbenzenes. The resulting increments are given on Table 7 and the equilibrium constant equations on Table 8. The resulting trend in the equilibrium constants is shown on Figure 2.

One predicts from these equilibrium constants that the hydrogenation of 2-methylnaphthalene should yield 6-methyl- and 2-methyl-1, 2, 3, 4-tetrahydrohaphthalene in the ratio 2.6 at 200° C and 2.2 at 300° C. The observed ratios were about 3 and 2, respectively, in autoclave experiments which appeared to have come to equilibrium.[1] Bailey[2] obtained a ratio of about 2 at 180 ± 25° C.

A further consequence of the aromatic ring stabilization by alkylation is that the symmetric octahydroanthracene or phenanthrene should be in excess over the asymmetric compound in the final hydrogenation product, as is indeed observed.[5] The equilibrium ratio of the isomers should equal $e^{1250/T}$ if o-xylene is accepted as the applicable analog. The extra

Since this article was submitted, new and very accurate naphthalene-tetralin-hydrogen equilibrium data have been presented by Wilson, et al.* They are in essential agreement with the predictions of this paper: at 390° C log K_p (calc.): —2.67, log K_p (found): —2.57, at 475°C: log K_p (calc.): —3.92, log K_p (found): —3.73, as is the heat of hydrogenation deduced from their equilibrium data: —32.0 ± 1.2 kcal/mole compared with —31.5 kcal/mole given in Table 2 of this article.

* Wilson, T. P., Caflisch, E. G., and Hurley, G. F., *J Phys Chem 62*, 1059 (1958).

TABLE 1—Calculation of the Heat of Hydrogenation from Resonance Energies (at 25° C)

REACTION	E_R kcal/mole	Ref.*	$-\Delta H'_h$ (from E_R) kcal/mole	$-\Delta H^o_h$ Conventional kcal/mole
Naphthalene + $2H_2$ = Tetralin	28.4[a]	13	29.0	31.5[b]
Tetralin + $3H_2$ = Decalin (trans)	38.7	13	46.1	47.3[c]
Naphthalene + $5H_2$ = Decalin (trans)	75	16	78	78.8[d]
Naphthalene + $5H_2$ = Decalin (trans)	67	13	76	

* The authors represent two different schools regarding the magnitude of E_R. The "high" values, proposed by Pitzer and by Pauling call for the use of propene as the reference olefin with $\Delta H^o_h/H_2 = -30.6$ kcal/mole; the low values (proposed by Magnus and Becker [13], by Kistiakowsky [10], and by Wheland [20], call for cyclohexene as reference olefin with $\Delta H^o_h/H_2 = -28.6$ kcal/mole.

[a] This value is E_R (naphthalene) - E_R (tetralin).

[b] This is average of the values derived from the heat of combustion data of Refs. 13, 15, and 19.

[c] This is the measured heat of hydrogenation of o-xylene [10].

[d] This is the average derived from the data of Refs. 13, 15, and 19; Myazawa and Pitzer [14] recommend —79.9 kcal/mole on the basis of more recent data.

TABLE 2—Standard Heat of Hydrogenation of Various Polynuclear Aromatic Hydrocarbons in the Vapor Phase at 25° C

REACTION	$-\Delta H^o_h$ kcal/mole		Calc.*
Naphthalene + $2H_2$ = Tetralin	31.5	±0.8	H_c
Tetralin + $3H_2$ = Decalin	47.3	±0.2	H_h
Naphthalene + $5H_2$ = Decalin (trans)	78.8[a]	±1.0	H_c, H_h
Phenanthrene + H_2 = 9, 10-dihydrophenanthrene	9.3	±2	H_c, E_R
Phenanthrene + $2H_2$ = 1, 2, 3, 4-tetrahydro-phenanthrene	23.0	±2	E_R, H_h
Phenanthrene + $4H_2$ = sym-octahydro-phenanthrene	54.9	±2	E_R, H_h
sym-octahydrophenanthrene + $3H_2$ = perhydro-phenanthrene	44.5	±2	E_R, H_c
Chrysene + $6H_2$ = dodecahydro-chrysene	83	±2	E_R, H_c
dodecahydrochrysene + $3H_2$ = perhydrochrysene	44.5	±2	E_R, H_c

* The symbols indicate the method of calculation: H_c = conventionally from heats of combustion; H_h = heat of hydrogenation of benzene analog; E_R = by means of resonance energy data (see Table 1).

[a] A more recent proposal is: —79.9 kcal/mole (14).

stabilization of the aromatic ring due to ortho positioning of two alkyl groups on the ring should cause partial isomerization of sym octahydroanthracene to sym octahydrophenanthrene, as has been observed in high temperature hydrogenation.[17] The equilibrium ratio of octahydrophenanthrene to octahydroanthracene should be of the order $e^{900/T}$, if the data of Table 7 can be applied. It is also apparent from these considerations, that alkylation of the external rings of anthracene and phenanthrene should reduce the thermodynamic preference of the symmetric over the asymmetric octahydrogenation products.

Other Applications. The reasoning that led to the application of $\delta_h(f)$ above can also be applied to other ring structures. A typical example is the hydrogenation of pyridine to piperidine. Assuming that $\delta_h(f)$ is the same as for benzene → cyclohexane, and using the reported values for the heats of formation of the reactants,[4,11,12] one obtains $\Delta H_h = -43.8$ kcal/mole and log $K_p = -3.5$ and -6.0 at 600 and 700° K, respectively. Recent experimental data by Hales and Herrington[8] yield for the same two temperatures log $K_p = -3.21$ and -5.71, respectively. The agreement is quite satisfactory.

LITERATURE CITED

[1] Archibald, R. C., Shell Development Company, private communication.
[2] Bailey, A. S. et al, J. Chem. Soc., 2731 (1956).
[3] Barrow, G. M., and McLellan, A. L., J. Am. Chem. Soc., 73, 573 (1951).
[4] Cox, J. D. et al, J. Chem. Soc., 265 (1954).
[5] Durland, J. R., and Adkins, H., J. Am. Chem. Soc., 59, 135 (1937); 60, 1501 (1938).
[6] Fetterly, L. C., Shell Development Company, private communication.
[7] Gunthard, H. H. et al, Helv. Chim. Acta., 34, 959 (1951).
[8] Hales, J. L., and Herrington, E. F. G., Trans. Faraday Soc., 53, 616 (1957).
[9] Hall, C. C., Fuel, 12, 76 (1933).
[10] Kistiakowsky, G. B., Vaughan, W. E. et al, J. Am. Chem. Soc., 59, 831 (1937).
[11] Kline, C. H., and Turkevich, J., J. Chem. Phys., 12, 300 (1944).
[12] Landolt-Bornstein, Tabellenwerk.
[13] Magnus, A., and Becker, F., Erdol u. Kohle, 4, 115 (1951).
[14] Myazawa, T., and Pitzer, K. S., J. Am. Chem. Soc., 80, 60 (1958).
[15] Parks, G. S., and Hatton, J. A., J. Am. Chem. Soc., 71, 2773 (1949).
[16] Pitzer, K. S., Quantum Chemistry, New York, 1953.
[17] Prokopetz, E. I. et al, J. Appl. Chem. (USSR), 11, 823, 850 (1938).
[18] Rossini, F. D. et al, API Project 44, Tables of Properties of Hydrocarbons.
[19] Szekely, A., Acta. Chim. Acad. Sci. Hung., 5, 317, 340 (1955).
[20] Wheland, G. W., Resonance in Organic Chemistry, New York, 1955.

TABLE 3—Thermodynamic Property Increments for Aromatic Ring Hydrogenation
(Calculated from data of Reference 1.)

T, °K	298	400	500	600	700	800
$-\delta_h$ ($F°-H°_2$)/T for alkylated benzene ring: cal/mole °K	2.6	3.6	4.7	5.9	7.2	8.5
$-\delta_h$ ($F°-H°_2$)/T for tetrahydrogenation of annelated ring: cal/mole °K	1.4	2.3	3.2	4.05	4.9	6.1
δ_h ($H°-H°_2$) for alkylated benzene ring: kcal/mole	.74	1.65	2.94	4.55	6.51	8.77
δ_h ($H°-H°_2$) for tetrahydrogenation of annelated ring: kcal/mole	.76	1.46	2.30	3.38	4.64	6.93

TABLE 4—Comparison of Two Different Calculations of the Free Energy Function Difference $\delta_h(f)$ for the Hydrogenation of Naphthalene to Decalin

T, °K	298	400	500	600	700	800
δ_h (f) from Table 3	5.0	5.9	7.9	9.95	12.1	14.6
δ_h (f) from Refs. 3 and 14	4.94	6.39	8.03	9.64	11.47	13.3

TABLE 5—Improved Free Energy Function Increments Based on detailed statistical Calculation of Refs. 14 and 19

PROCESS	T, °K 298	400	500	600	700	800
Tetrahydrogenation of annelated ring (naphthalene to tetralin), δ_h (f)	1.4	2.3	3.2	4.0	4.9	6.1
Hydrogenation of tetralin to tr-decalin, δ_h*(f)	3.6	4.1	4.8	5.6	6.6	7.3

TABLE 6—Comparison of Equilibrium Constants Obtained by the Method of this Report with those Obtained by Detailed Calculation in Ref. 14 for the Hydrogenation of Naphthalene to Decalin

	T, °K 500	600	700	800
log K_p, using data of Tables 1 and 3	1.79	—4.07	—8.38	—11.69
log K_p, calculated in ref. 14	2.22	—3.97	—8.44	—11.81

TABLE 7—Effect of Alkyl Chains on Hydrogenation Increments of Thermodynamic Properties

Arrangement of Alkyl Chains	$\delta_a \Delta H°_h$ (kcal/mole)	δ_a ($F°-H°_2$)/T (cal/mole °K) 600°K	700°K	δ_a ($H°-H°_2$) kcal/mole 600°K	700°K
Single	0.9	1.1	1.1[a]	.5	.7[a]
Two in ortho position	2.5	0.7	0.8	0	0[b]
Three in 1, 3, 5 position	2.2	Unknown		Unknown	

[a] Compared with benzene.
[b] Compared with singly alkylated rings.

About the Author

A. Bondi is a supervisor for Shell Development Co., Emeryville, Calif., where he supervises process development projects and the development of methods to predict physical properties of chemical equilibria. He joined Shell Development in 1947 from International Lubricants Corp. in New Orleans. Bondi has spent much of his career in the development of lubricants and other petroleum products, and the processes to make them. He has authored 45 papers in the field of physical chemistry and rheology, is a contributor to the Kirk-Othmer (Interscience) Encyclopedia of Chemical Technology, the Clark-Hawley Encyclopedia of Chemistry, the Source Book on Rheology, and has written a book, "The Physical Chemistry of Lubricating Oils."

TABLE 8—Equations Used for the Calculation of Equilibrium Constants and Thermodynamic Properties

(Valid Between 500 and 800° K.)

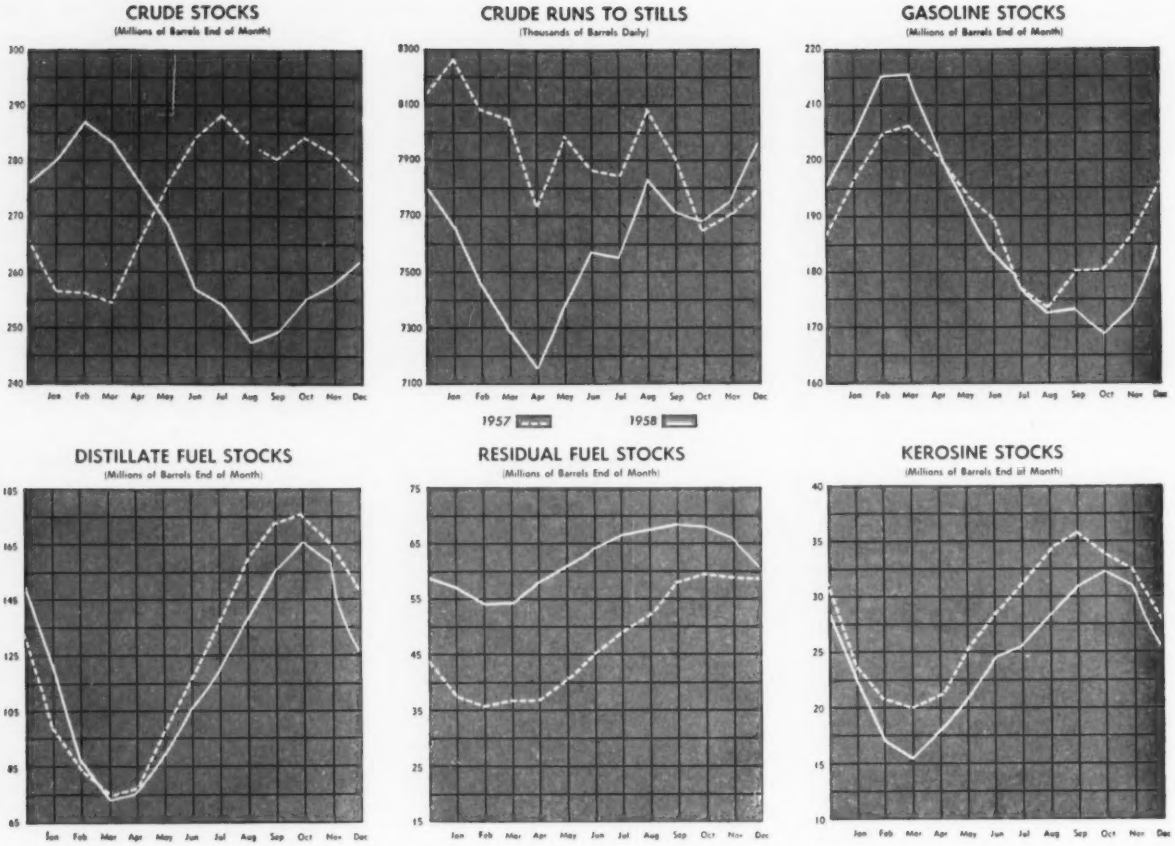
$$(\Delta H_h°)_o = \Delta H_h° + n \times 2{,}032 - m \times 745$$

$$\log K_p = 0.2186 \left\{ \frac{(\Delta H°)_o}{T°} + m_1 (1.95 - 0.010T) + n (16.05 + 0.533T^{1/2}) \right\}$$

$$\log K_p (A_1) = \log K_p - 0.2186m \left(\frac{900}{T}\right)$$

$$\log K_p (A_2) = \log K_p - 0.4372m \left(\frac{900}{T}\right)$$

$\log K_{(p)} = \log K_p + n \log p$
n = number of hydrogen molecules required in the stoichiometric reaction
m_1 = number of annellated rings tetrahydrogenated in the reaction
m_2 = number of six-rings fully hydrogenated in the reaction
$m = m_1 + m_2$
A_1 refers to compounds with one alkyl chain per ring
A_2 refers to compounds with two alkyl chains per ring



Taking Stock

- Crude stocks still climbing
- Distillates drop sharply
- Residuals leveling off

U. S. Monthly Oil Trends

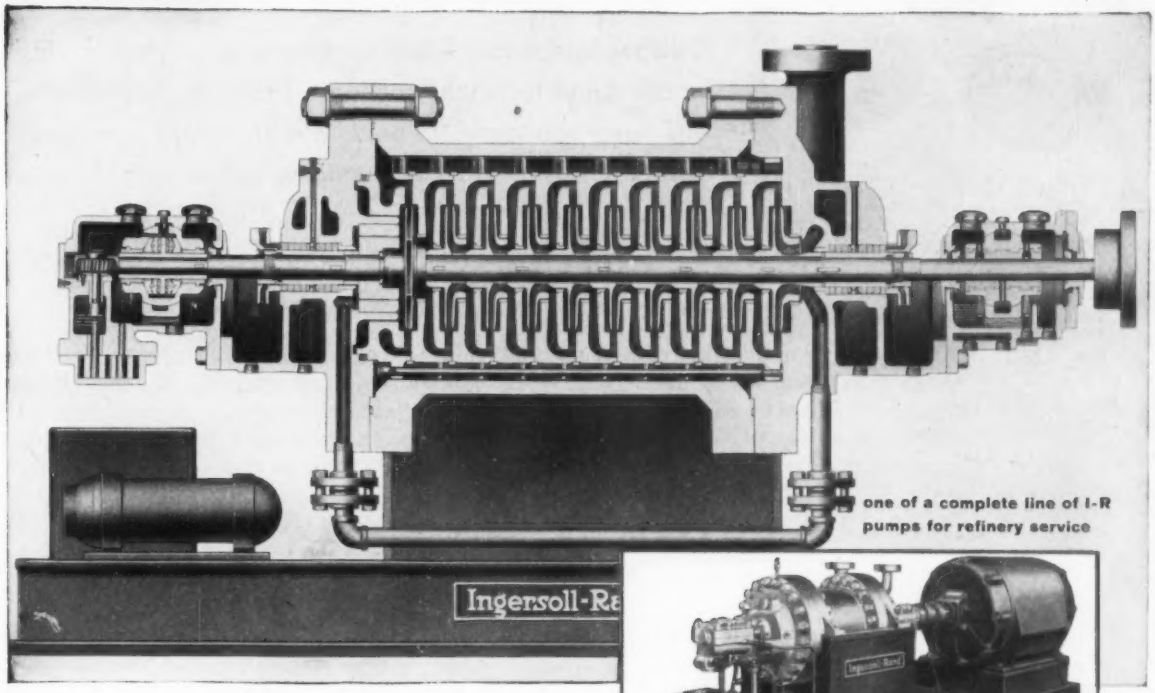
(THOUSANDS OF BARRELS DAILY)

	December			Nov.	Year		
	1958	1957	% Diff.	1958	1958	1957	% Diff.
U.S. Crude Oil Production	7,105	6,929	+ 2.5	6,990	6,707	7,174	— 6.5
U.S. Nat. Gas Liquids Prod.	820	819	+ 0.1	810	790	806	— 2.0
U.S. Total Imports	1,935	1,724	+12.2	1,809	1,665	1,544	+ 7.8
East Coast Crude Imports	792	759	+ 4.3	806	768	737	+ 4.2
Total Crude Imports	1,039	1,020	+ 1.9	1,000	953	997	— 4.4
Total Refined Products	803	704	+14.1	809	704	548	+28.5
Total New Supply	9,860	9,473	+ 4.1	9,609	9,162	9,526	— 3.8
Stock Changes All Oils (Daily)	—984	—535	.....	—117	—140	+168	.....
Total Demand All U.S. Oils	10,844	10,008	+ 8.4	9,726	9,301	9,359	— 0.6
Gasoline Demand	3,786	3,703	+ 2.2	3,844	3,952	3,923	+ 0.7
Distillate Fuel Demand	3,091	2,474	+24.9	2,098	1,884	1,819	+ 1.4
Residual Fuel Demand	1,854	1,774	+ 4.5	1,493	1,487	1,589	— 6.4
Domestic Demand, All Oils	10,559	9,702	+ 8.8	9,416	9,020	8,797	+ 2.5
Export Demand, All Oils	285	306	— 6.9	310	282	562	—49.8
Crude Runs U.S. Refineries	7,956	7,816	+ 1.8	7,768	7,604	7,919	— 4.0
Domestic Crude Runs	6,952	6,880	+ 1.0	6,785	6,663	6,936	— 3.9
Foreign Crude Runs	1,004	937	+ 7.2	983	942	983	— 4.1

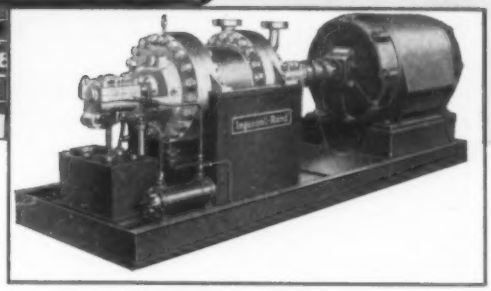
	TOTAL U.S. STOCKS Millions of Barrels End of Month				STOCKS EAST OF CALIFORNIA Millions of Barrels End of Month			
	December			Nov.	December			Nov.
	1958	1957	% Diff.	1958	1958	1957	% Diff.	1958
Crude Oil	262.9	281.8	— 6.7	258.1	223.6	238.9	— 6.4	220.7
Gasoline	186.2	196.8	— 5.4	173.9	160.8	168.3	— 4.5	150.6
Distillate Fuel Oil	126.7	149.4	—15.2	159.0	114.1	133.4	—14.5	145.4
Residual Fuel Oil	60.7	60.0	+ 1.2	65.7	28.5	33.4	—14.7	32.4
Kerosine	26.1	29.2	—10.6	31.5	25.7	28.8	—10.8	31.2

Source: Except for latest two months, all data from U.S. Bureau of Mines. Data for last two months from American Petroleum Institute weekly reports and U.S. Bureau of Mines weekly crude stock report; except U.S. Natural Gas Liquids Production and Demand figures which are from WORLD OIL.

NEW INGERSOLL-RAND CHARGE PUMPS
Offer Longer Life on High-Pressure Process Service



one of a complete line of I-R pumps for refinery service



. . . *featuring proved "Unit-Type" Rotor Assembly*

The new Ingersoll-Rand CMR pump is specifically designed for high-pressure process service, where operation without a spare requires top performance and exceptional dependability. It is a horizontal, multistage unit with vertically-split barrel-type casing, suitable for a wide range of low-capacity, high head applications in refineries or other process plants.

Available in 1½ and 2½ inch discharge sizes, the CMR pump will efficiently handle capacities up to 400 gpm, pressures to 1500 psi and temperatures to 750°F.

Some of the outstanding features are noted below. For complete information, contact your Ingersoll-Rand representative.

FEATURES:

- **High-Strength Casing** . . . The main barrel is made from centrifugally-cast steel with forged steel ASA flanges welded at both ends. The nozzle head and discharge head are one-piece carbon steel castings which bolt to the casing flanges. The main casing joints are sealed with confined flexitallic gaskets. The pump can be dismantled without disturbing the piping connections.
- **"Unit-Type" Rotor Assembly** consists of separate channel ring segments, impellers and shaft. It can be easily removed from the pump as a unit to facilitate maintenance.
- **Impellers and Wearing Rings** . . . The single-suction, closed type impellers are cast in one piece and mechanically balanced to assure smooth, vibration-free operation. Casing rings, pressed into the channel rings, and locked against rotation, are easily renewed to maintain close running clearances.
- **Hydraulic Balance** . . . Multiple-volute diffusor construction completely eliminates radial thrust. A balancing drum effectively counteracts axial thrust due to pressure differentials across each stage. Residual thrust is taken up by the thrust bearing.
- **Bearings** . . . Spherically seated, self-aligning Kingsbury thrust bearing and sleeve-type radial bearings are pressure lubricated by a gear oil pump driven from the outboard end of the shaft. An oil reservoir and shell and tube-type cooler are mounted on the pump base.

Ingersoll-Rand

10-795 11 Broadway, New York 4, N. Y.

PUMPS • COMPRESSORS • GAS & DIESEL ENGINES • AIR & ELECTRIC TOOLS • TURBO BLOWERS • CONDENSERS

Valuable Reading Ahead

Here's a quick run-down on what's presented in this month's non-technical sections. These departments will keep you right up-to-date with what's new and different in this rapidly changing oil industry.

My! Times Do Change

That's why you should read "Changing Times," a fast moving account of those items that made news in the industry last month. It is just what the doctor ordered for busy industry men who don't have time to wade through many paragraphs to get to the meat of the subject. And, right after "Changing Times" is REFINER's handy meetings calendar, now expanded to two columns so you will have word of important events in the industry months in advance. See for yourself!

Keep Going to Page 213

You Should Know

"What Suppliers Are Doing" is the department where you will find information you need to know about the companies and men that supply the oil, gas and petrochemical processing industry. This handy guide will help you keep up with the people who serve your plant, and any extension of facilities which will be of service to you.

Keep Going to Page 225

Who's Meeting Where

You'll find out when you read PETROLEUM REFINER's "Meeting Calendar"—that easy-to-read tabulation of what's coming up in the societies and associations that are of most interest to you. It's the type of thing you'll want to clip out and keep around so you can refer to it at a moment's notice.

Keep Going to Page 214

New Chromatograph

A new high-temperature chromatograph capable of separating and analyzing substances with boiling points up to 600 C is now available. Learn all about this and many other new developments in PETROLEUM REFINER's "New Equipment" section.

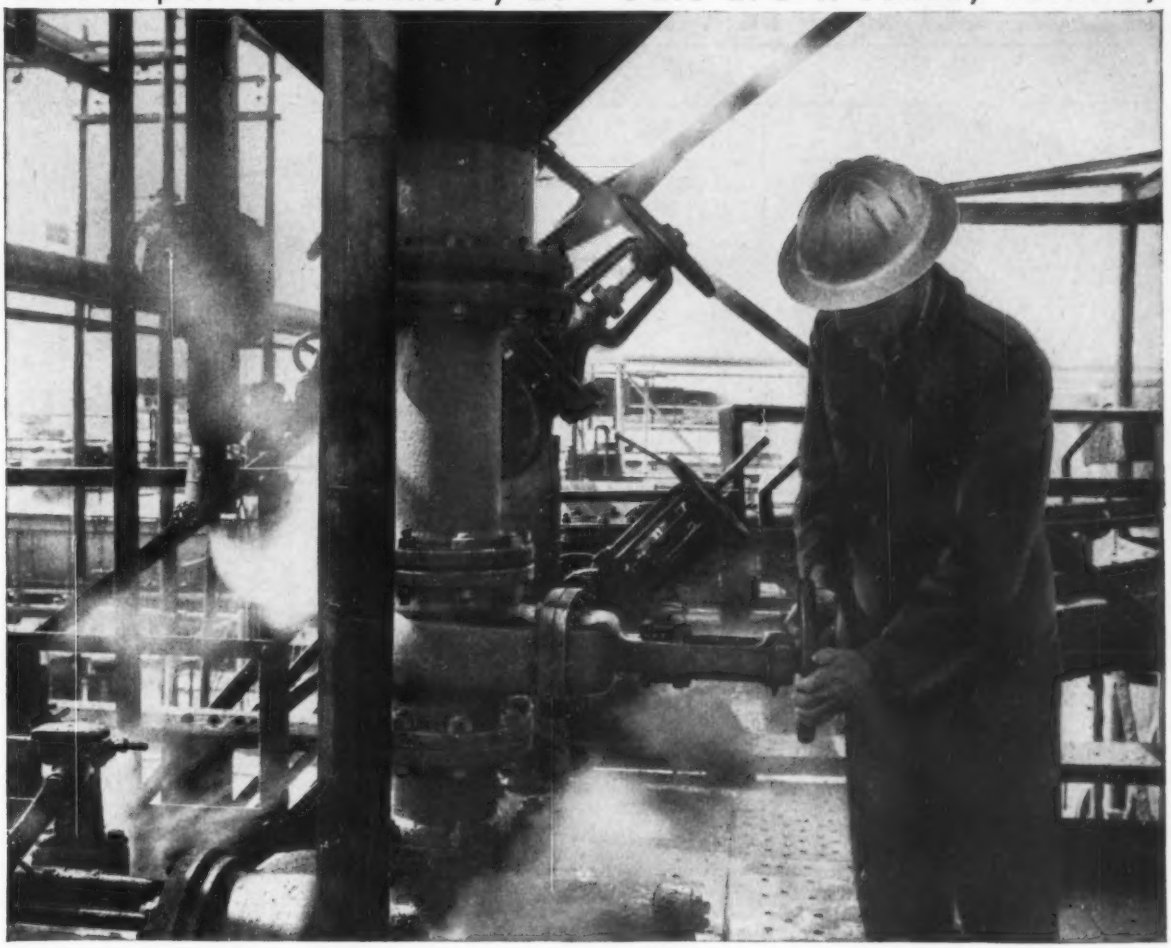
Keep Going to Page 244

Management Sees It This Way

If you're not acquainted with PETROLEUM REFINER's "As Management Sees It . . ." section, then you are missing some good information specifically written for managers, supervisors, and foremen, and for those persons aspiring to such positions. This month's lead article thoroughly explores the subject of professionalism among engineers. It contends that although the engineer is a truly professional man the same as the doctor or lawyer, he has a hard time earning this status in the community. You'll get a good insight into this problem when you read "What Price Professionalism?"

Keep Going to Page 193

Case Report on "Craneloy 20" Gate at D-X Sunray Refinery



Best valve performance ever on toughest acid service . . .

. . . So says the D-X Sunray Oil Co. about this "Craneloy 20" gate on sludge draw-off at the big West Tulsa refinery.

Installed at the agitator bottom, this 6-inch Crane valve is handling various hot sulphuric acid sludge mixtures—concentrated and weak—steam-diluted to as low as 30%.

Valves used previously had to be replaced every 3 to 6 months. But this "Craneloy 20" gate went a full 14 months before minor repairs—then was put right back into service. It has the best record of any valve used on this toughest job in the refinery.

Specially developed for sulphuric acid at elevated temperatures, "Craneloy 20" is a high-nickel, high-chromium stainless. Teamed with Crane split-wedge, rotating-disc seating design, it makes a valve no corrosive fluid processor can afford to overlook for truly low-cost flow control.

GET FULL FACTS on "Craneloy 20" and other Crane quality alloy valves and fittings. Ask your Crane Representative for Circular AD-2080, or write to address below.

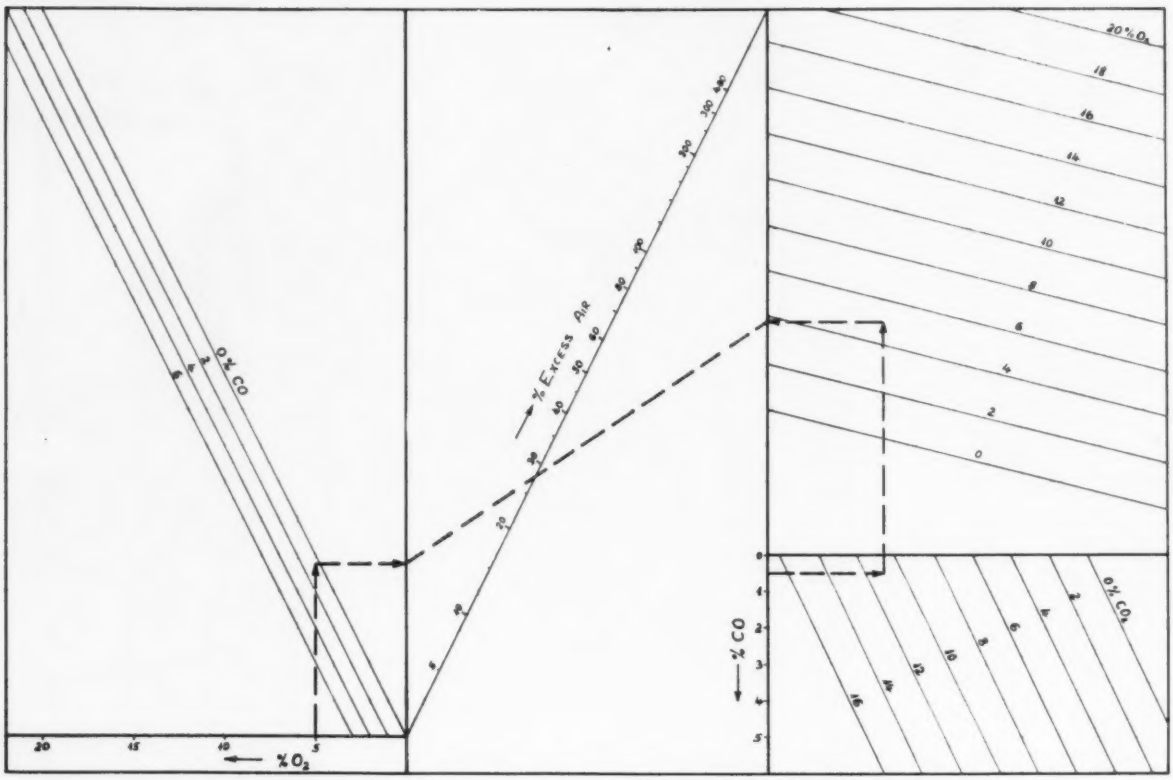
CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill.—Branches and Wholesalers Serving All Areas

For more data on advertised products, use Readers' Service Cards, last page.

How To Do It . . .



Determine Excess Air in Combustion

All you need are volume percents of oxygen, carbon monoxide and carbon dioxide in flue gases

It is easy to find the percent of excess air in a combustion process by using this handy "How To Do It" nomograph.

The only data you need are the volume percents of oxygen, carbon monoxide and carbon dioxide in flue gases, as obtained by the Orsat analysis. The advantage of this method, which is no approximation, because it is based on a material balance, is the independence of fuel composition, i.e., it is very useful in case you burn fuel oil and gas in varying proportions.

Example: A flue gas has the following composition (Orsat analysis):

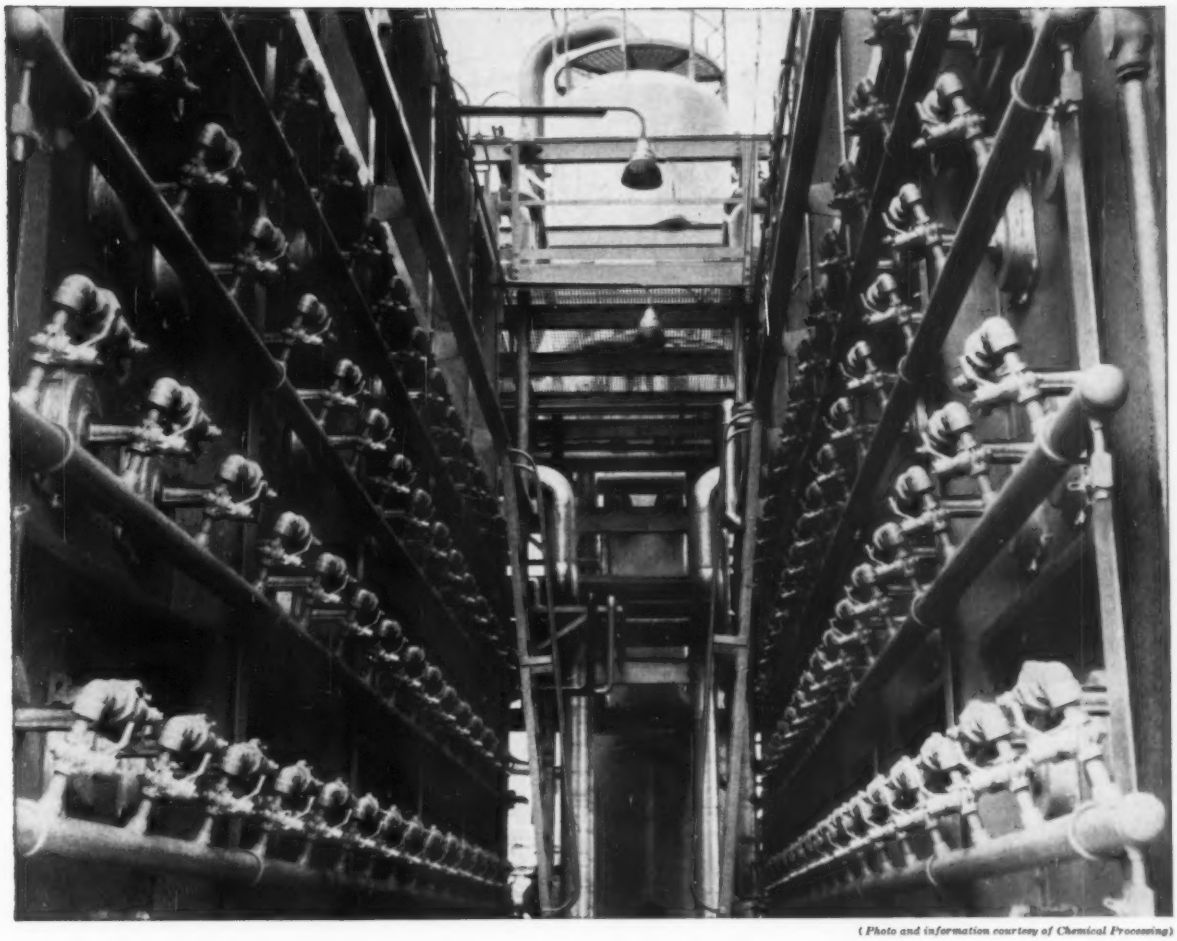
- Oxygen 5.0 percent
- Carbon monoxide 0.5 percent
- Carbon dioxide 11.0 percent

Following the segmented lines, you obtain 28 percent excess air. The calculated result would be 27.5 percent.

This idea was submitted by Klaus Lothholz W., Empressa Nacional Del Petroleo, Concon, Chile.

Drafting Tips Make Piping Drawing Easier

A plastic circle template with holes in increments of 1/32 inch or 1/64 inch may be used to draw pipe and long radius well ells accurately to the scale $\frac{3}{8}'' = 1'-0''$. Designate each hole with a number corresponding to the number of 64ths of an inch in the diameter. The $\frac{1}{8}$ inch diameter hole is #8; the $\frac{1}{2}$ inch diameter hole is #32; the $\frac{3}{4}$ inch diameter hole #48, etc. These numbers may be lettered on the plastic with India ink and covered



(Photo and information courtesy of Chemical Processing)

Two years of high ethylene conversion with low tube maintenance shows...

How Incoloy tubing stops "cracking" furnaces from burning up money

In 1956, National Petro-Chemicals Corporation of Tuscola, Illinois installed three Selas "cracking" furnaces for conversion of ethane to ethylene. Stone & Webster Engineering Corporation provided process and engineering services. Capacity for each furnace – 60 tons of ethane per day.

In 1958, National Petro-Chemicals reported ". . . hardly any downtime . . . very little tube maintenance required in spite of the 1500°F temperature of operation." (Tube wall temperatures are about 1700°F).

One reason cited for this record is furnace design. The photo above shows how the tubes and burners are positioned for uniform heating.

Another reason – the extruded Incoloy* iron-nickel-chromium alloy tubing. This alloy is particularly suitable for this type of service. It has the ability to remain stably austenitic when subjected to prolonged heating. It also has high resistance to carburization, a safety factor during decoking.

And by using Incoloy tubing in the relatively inexpensive extruded form, a distinct price benefit is realized.

The right properties for your applications, too. You'll find that Incoloy alloy also exhibits high creep strength and rupture strength combined with ductility. And of special importance for your pressure applications is the alloy's ability to provide sound welds.

For more information, write for free booklet "Which Alloy For High Temperature Processes?"

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

*Registered trademark

INCO NICKEL ALLOYS

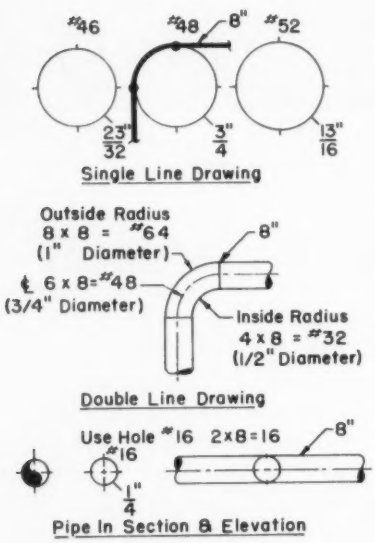
with clear finger nail polish to prevent wearing off.

For a single line drawing, multiply the nominal pipe diameter by 6 and use the hole with the corresponding number as a template to draw the weld ell to scale. To draw an 8 inch, long radius, 90 degree weld ell, use hole #48 (¾ inch diameter) 6x8 = 48.

For double line drawings, use the above method to locate the center line of the weld ell. To draw the inside radius, multiply the nominal pipe diameter by 4 and use the corresponding hole number. To draw the outside radius, multiply the nominal pipe diameter by 8 and use the designated hole.

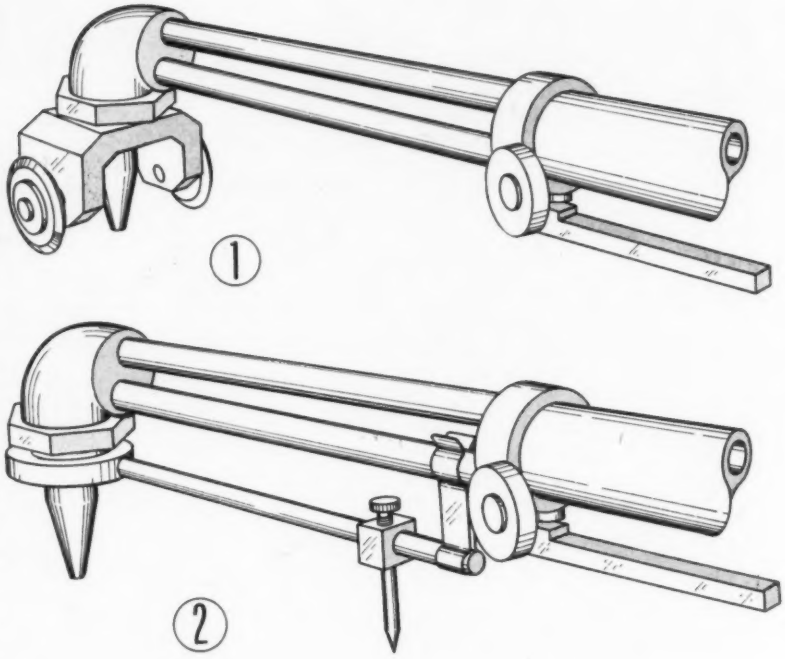
To draw a pipe in section, multiply the nominal pipe size by 2 and use the designated hole.

To draw a pipe in elevation or plan, also multiply by 2 and position



the correct hole number over the center line of the pipe on the drawing. With a sharp pencil make a dot at the upper and lower edges of the hole 180 degrees apart, remove the template and draw lines through these points which represent the outside edges of the pipe.

This idea was submitted by W. B. Carlin, Decatur, Ala.



Adaptors Aid in Easier Torch Cutting

It's tiresome and tedious to make long cuts with a torch. A simple adaptor for the tip can be made that will make those long cuts a pleasure.

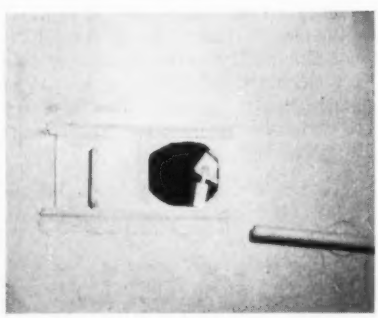
From a piece of bar stock or steel plate, cut the adaptor body similar to that shown in drawing 1. Attach two paper cutter wheels with pins through the adaptor legs. Drill and tap the adaptor neck for a set screw. Now, scribe a line on the work to be cut, fire up your torch and away you go.

The handy idea illustrated in drawing 2 will enable you to make a small circular cut with a torch, using a simple attachment for a guide.

Attach a circular ring, cut from pipe or made from bar stock, to a ⅜-inch rod. Drill a $^{13}/_{32}$-inch hole in a piece of bar stock to act as a slide on the rod. Drill and tap the slide for a ¼-inch set screw and pointer, as shown. Weld a clamp to the opposite end of the rod and attach this demountable, circle-cutting attachment to the torch. By adjusting the slide pointer to the radius of the circle desired, a perfect cut can be made every time.

These ideas were submitted by Jack O. Evans, E. I. du Pont de Nemours and Co., Victoria, Texas.

Lock Door With Padlock on the Inside



A simple lock for your tool house door may be made by simply extending the latch to a bracket inside the door and placing the lock in the matching holes. A sliding door may be placed over the lock which keeps it out of the weather and makes it difficult to tamper with.

The latch hooks into the door from the inside and comes through the door to the handle (horizontal bar in photo). This enables simple, easy op-

CONDENSER TUBE CLINIC

Edited by **ARTHUR W. TRACY**, Metallurgical Engineer,
The American Brass Company, Waterbury, Connecticut

Stresses and their Effects can be Minimized

STRESS-CORROSION CRACKING—The stress-corrosion cracking of copper alloys requires the simultaneous action of moisture, air, ammonia, and stress. Stresses may be residual or applied. All Anaconda condenser tubes are processed so as to minimize residual tensile stresses which may be formed during fabrication. Applied stresses from installing tubes in heat exchangers, nonuniform thermal expansion in tube bundles, or misalignment of condensers with other equipment occasionally cause stress-corrosion cracking.

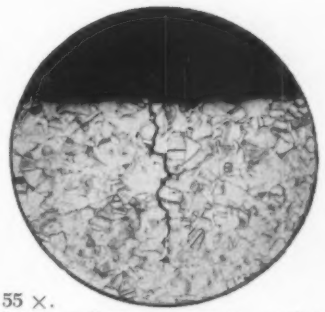
Admiralty metal and aluminum brass tubes, although known to be susceptible to stress-corrosion cracking, seldom crack in condensers. Although ammonia is often present, either by chance or design, in vapors entering condensers, the amount of air (oxygen) is usually so small that the corrosive action of the ammonia is limited. It is obvious that noncondensable gases should be vented from condensers, not only to increase thermal efficiency, but to minimize corrosion.

ANACONDA Arsenical Admiralty-439 and ANACONDA Ambraloy-927 condenser tubes seldom stress-corrosion crack in normal service. Where operating conditions are severe enough to cause stress-corrosion cracking of these alloys, ANACONDA Cupro Nickel, 10%-755 and ANACONDA Cupro Nickel, 30%-702 tubes are recommended.

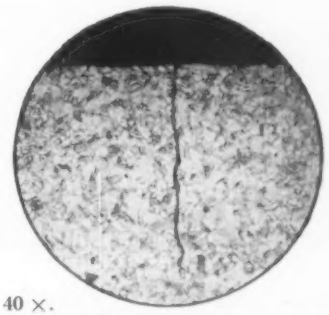
STRESS-RELIEF ANNEALING – Inasmuch as copper-alloy condenser tubes may stress-corrosion crack from stresses caused by cold-forming operations such as U-bending, the stresses should be removed by relief annealing the cold-formed portion of the tube.

FATIGUE CRACKING – Vibrations from moving parts of equipment or from pressure pulsations can induce stresses in condenser tubes high enough to exceed the endurance limit and cause a fatigue-crack failure. Vibration of a tube may even disturb water flow enough to cause impingement pitting at the point of greatest amplitude of vibration and the resulting pits can act as stress raisers. Pulsations can often be dampened by placing baffles or grids in the path of high-velocity vapors. Vibration of tubes can also be dampened by placing wooden slats between rows of tubes. Cupro Nickel, 30%-702 Tubes are more resistant to fatigue cracking than admiralty and aluminum brass.

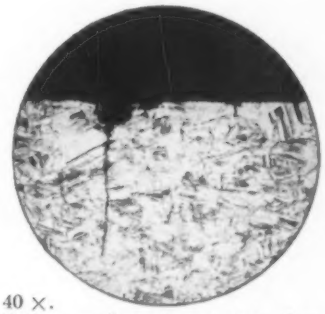
TECHNICAL ASSISTANCE—Your tube problem may need special consideration. We are always ready to advise in the selection of the right alloy to give the best service. Write for the new edition of Publication B-2. The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5878



55 ×.
Intergranular stress-corrosion crack in 70/30 brass tube from oil refinery heat exchanger. Longitudinal section.



40 ×.
Transgranular stress-corrosion crack in admiralty metal tube from oil refinery heat exchanger. Longitudinal section.



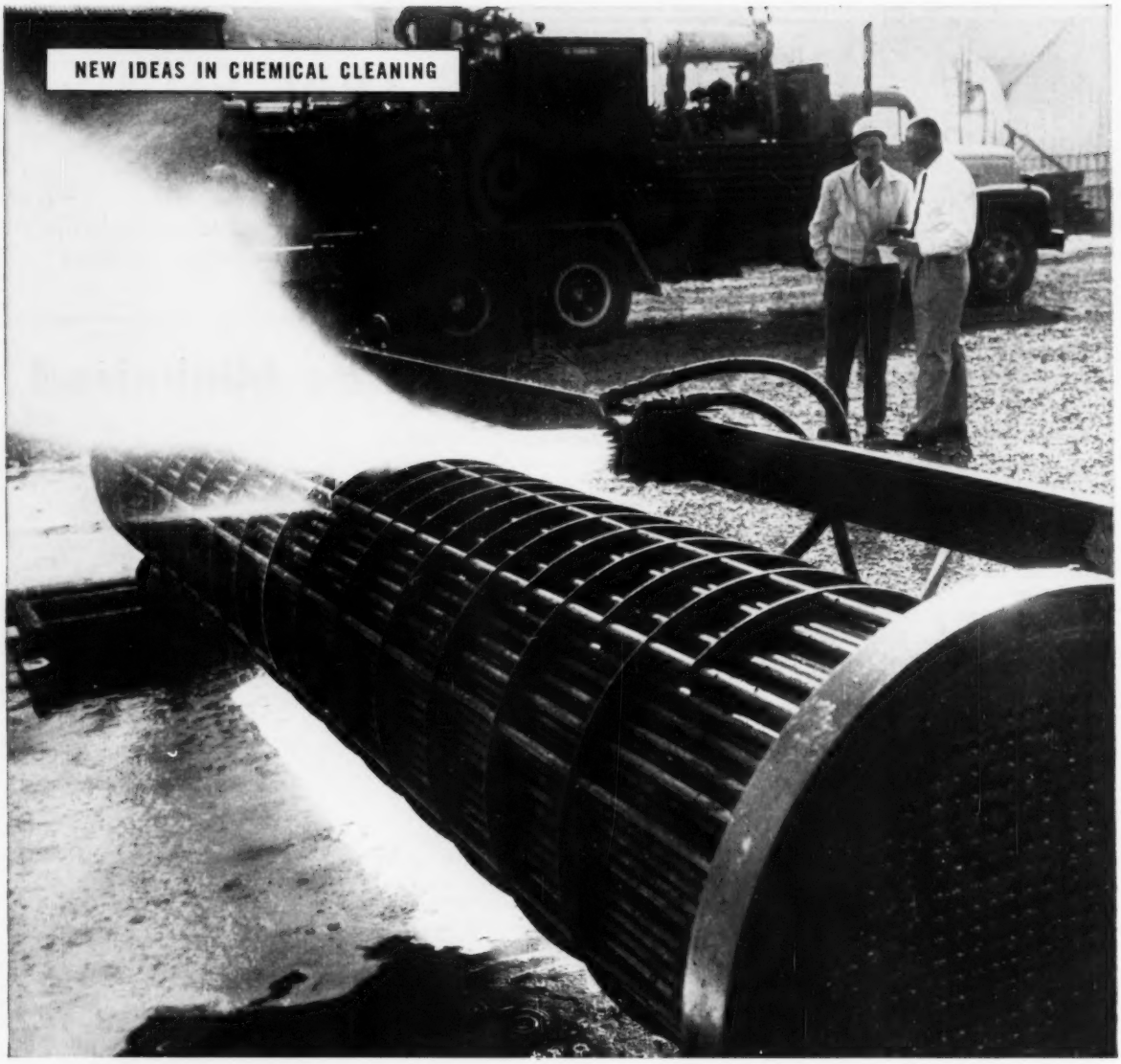
40 ×.
Fatigue crack starting at pit in aluminum brass tube from power plant condenser. Longitudinal section.

ANACONDA® **Tubes and Plates for Condensers and Heat Exchangers**

NOMINAL COMPOSITIONS OF SOME ANACONDA CONDENSER TUBE ALLOYS

	Arsenical Admiralty-439	Ambraloy-927 (Aluminum Brass)	Cupro Nickel, 10%-755	Cupro Nickel, 30%-702
Copper, %	71	77	88.35	68.90
Nickel, %	..	..	10	30
Zinc, %	27.96	20.96	..	..
Aluminum, %	..	2	..	..
Tin, %	1	..	..	..
Arsenic, %	0.04	0.04	..	..
Manganese, %	..	..	0.40	0.60
Iron, %	..	..	1.25	0.50

For more data on advertised products, use Readers' Service Cards, last page.



New Jetting Tool To Clean Tube Bundles Saves Thousands Of Dollars

The new high-pressure hydraulic tool, shown above, is currently saving thousands of dollars for companies in the refining, chemical, and petrochemical industries. It is the jetting tool developed by Dowell to remove deposits from heat exchanger tube bundles.

Previous methods of cleaning these bundles have been costly, time-consuming and often inadequate. Many times bundles had to be replaced completely because of the lack of a suitable cleaning method.

This new Dowell tool has a remarkable record of thorough, fast cleaning. For example, a slurry reboiler exchanger bundle, three feet in diameter and 16 feet long, was fouled with deposits of coke and asphalt. After being jetted from only one side, the bundle was thoroughly clean. Time required: less than one hour.

The tool holds the bundle in place for cleaning and has flanged rollers for rotation. The jet-head is manipulated automatically so that all tube spaces are covered. The jetted liquid can be either water or chemical solvents.

This high-velocity jetting device is another example of the new ideas Dowell continues to offer in chemical cleaning to help you cut your costs. Whatever the cleaning problem in your plant, call Dowell for an engineered recommendation. Dowell — the largest, the oldest, the most experienced chemical cleaning service — Tulsa 1, Oklahoma; and 165 stations and offices in major industrial centers.

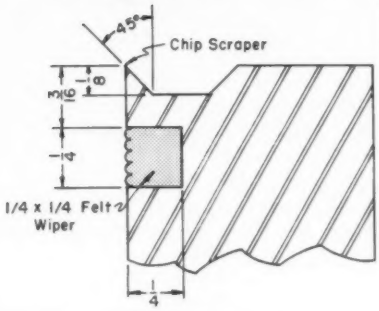
Chemical cleaning service for all industry DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

eration. A hole is then cut into the door a few inches from the handle, and grooves are welded on each side which act as lock door slides.

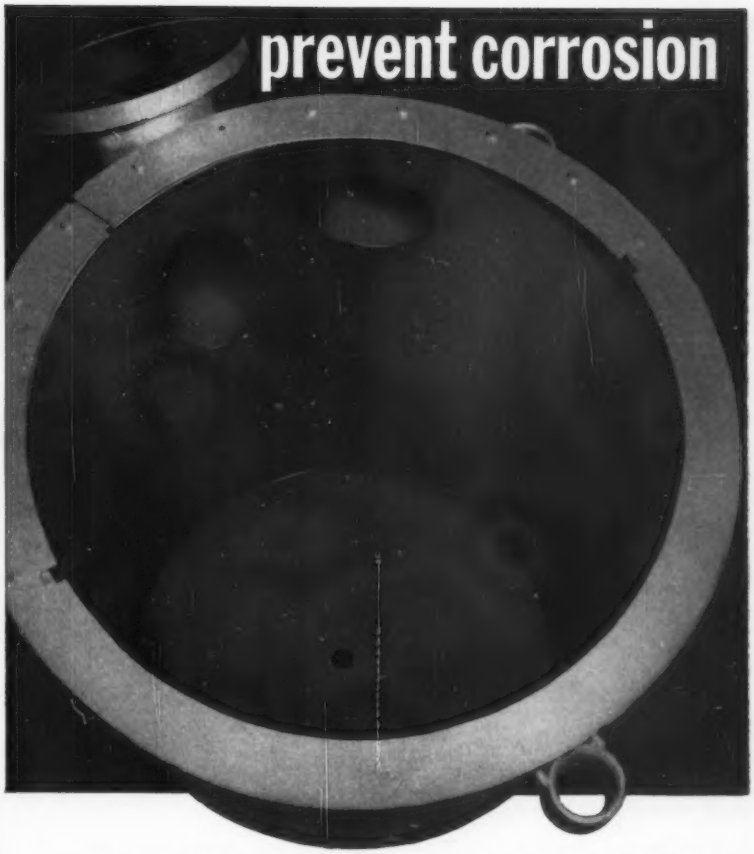
After the door is fitted, a bar is drilled near the end to match a bar welded to the inside of the door. The other end of the bar is welded to the door latch. Then, when the lock is inserted, the door is locked, but the door can be latched without using the lock.



Boring Mill Aid Eliminates Dirt in Tail Stock Bushing

The tail stock bushing on a boring mill will often clog with dirt during operation. By milling each end of the bushing, as shown, and installing a piece of felt to act as a wiper, the dirt problem is solved and the bar slides freely at all times.

This idea was submitted by M. E. Buquoi, Ethyl Corp., Baton Rouge, Louisiana.



...with CHEMISEAL® Fluorocarbon Plastic linings

From a reactor pot to a tank truck—Chemiseal Fluorocarbon Plastic linings, offer the way to make any ordinary equipment and piping extremely resistant to acids, alkalies, oxidants and solvents at temperatures up to 350°F—and at reasonable cost.

Chemiseal Fluorocarbon Plastic sheet, Garlock No. 9574, is durable, shatterproof, abrasion resistant, chemically inert. It is readily cemented over any contour and to any material of construction—metal, wood, concrete, etc. Being a thermoplastic resin, seams may be "welded", on the job by the thermal pulse technique, into a continuous chemically-impregnable lining.

CERTIFIED APPLICATORS—Chemiseal Fluorocarbon Plastic lining material is available for installation by the following certified applicators.

Atlas Metal Protection, Inc., Houston, Texas
The Barber-Webb Company, Inc., Los Angeles, Cal.
Belke Mfg. Co., Inc., Chicago, Ill.
Buckley Iron Works, Dorchester, Mass.
Electro-Chemical Engrg. & Mfg. Co., Emmaus, Pa.
Metalweld, Inc., Philadelphia, Pa.

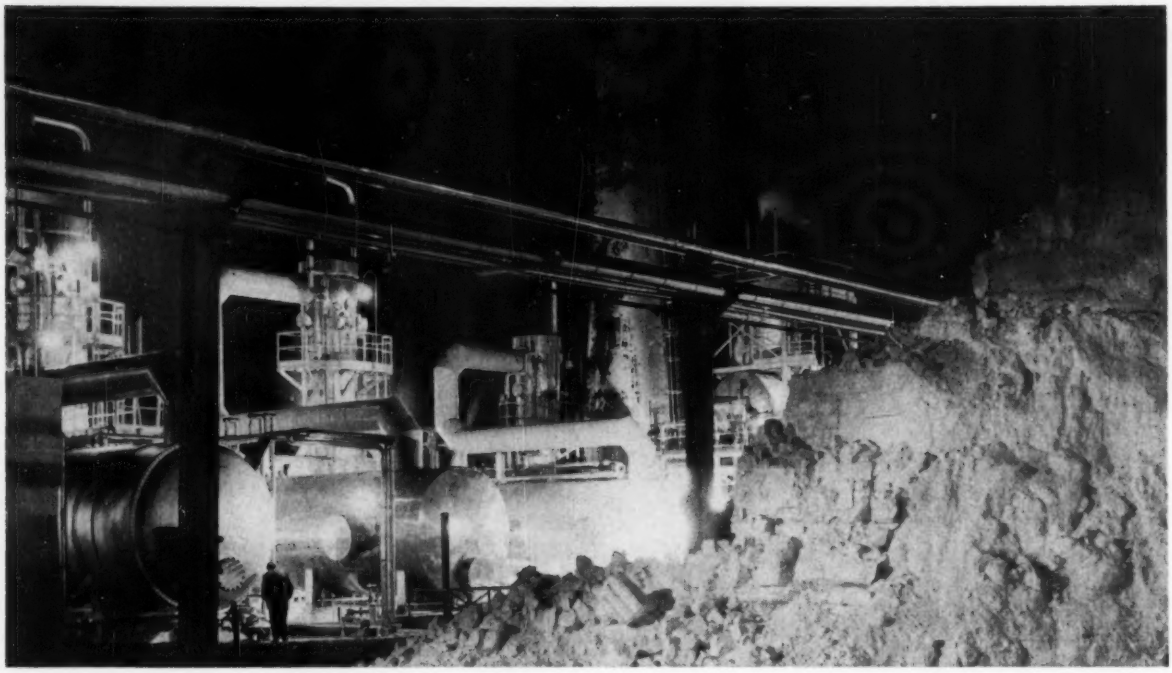
Write for Bulletin AD-152.

Special Products Department
UNITED STATES GASKET COMPANY
Camden 1, New Jersey

United States Gasket
Plastics Division of GARLOCK

For more data on advertised products, use Readers' Service Cards, last page.

Who's Building . . .



Societe Nationale des Petroles d'Aquitaine's sulfur unit in the first production stage produces 200-metric-tons of sulfur a day.

Second Stage of Lacq Plant Complete

Facilities at new French plant feature unique deep gas deposit with aromatic-rich condensate

THE SECOND STAGE of the natural gasoline plant at Lacq field in Southern France went partially on stream in October, 1958. The second stage will process about 140 Mmcf of raw gas daily, producing about 85-Mmcf of processed pipe line gas, 800 metric tons of sulfur,1,100 bpd of natural gasoline, and about 600 bpd of propane. Butane and ethane are produced in quantity also. Additional expansion stages were planned. Societe Nationale des Petroles d'Aquitaine (SNPA), the French government company holding the Lacq field concession, had the third stage under construction, and has reportedly been discussing construction contract tenders for a fourth.

By 1961, facilities to process 700 Mmcf of raw gas daily are expected to be on stream. The big Lacq Gas field, with at least 5.3-trillion cubic feet in reserve, and possibly 10 trillion, is expected to satisfy a significant proportion of France's fuel needs in the future. Sulfur production there almost fulfills the nation's sulfur demand.

The Lacq facilities are perhaps not as unique as the deep gas deposit itself, which supplies gas having the composition shown in Table 1. The raw gas is composed of 16.8 percent hydrogen sulfide, and the liquid hydrocarbons are rich in aromatics, particularly toluene and xylenes. Lacq is probably the only gas field

TABLE 1
Raw Gas Analysis

Constituent	Volume Percent
C_1	69.5
C_2	2.6
C_3	1.2
C_4 iso	0.17
C_4 N	0.34
C_5 iso	0.12
C_5 N	0.13
C_5 cyclo	0.04
C_6+	0.20
inerts	0.4
H + He	0.02
CO_2	8.2
H_2S	16.8
COS	0.037
CS_2	0.065
RSH	0.02

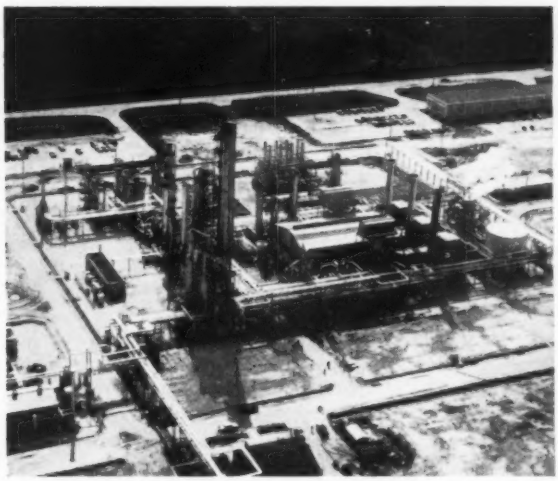
LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

385 Madison Avenue New York 17, N. Y.

200,000,000 LB. PER YEAR ETHYLENE PLANT FOR PETROLEUM CHEMICALS, INC. ON STREAM

Lummus Designs, Engineers and Constructs Plant to Pipeline 99.7+ Percent Ethylene



Petroleum Chemicals, Inc. new ethylene plant at Lake Charles, Louisiana is now on stream. Initial ethylene product capacity is 600,000 lbs/per day but Lummus has designed the plant for rapid expansion to a rate of 900,000 lbs/per day. Ethylene will be produced in two grades – the highest grade is 99.7% assay and the other grade 98%. Co-products will be high assay propylene, a butane-butylene fraction and aromatic distillate. Operations have been marked by continuous production of specification high assay ethylene under widely varying rates and feed stock compositions.

The plant incorporates a new ethylene separation process developed by The Lummus Company which provides high separation efficiencies and unusual flexibility and reliability. Feed gases for the ethylene plant are provided from three sources; the nearby refineries of Cities Service and Continental Oil – by whom P.C.I. is jointly owned – and P.C.I.'s new ammonia plant. P.C.I.'s high assay ethylene is delivered via pipeline to customers at Orange, Texas. Part of the new plant's output feeds the adjacent Calcasieu Chemical Corporation's new ethylene oxide and glycol plant, also engineered and constructed by Lummus.

Ethylene is used in the manufacture of polyethylene plastics, anti-freezes, synthetic rubber products, tetraethyl lead and liquid detergents.

Cracking section of the plant features an improved Lummus heater which embodies years of research and development by Lummus' Oil Heater Division.

All major compressors in the Lummus designed low temperature fractionation unit are driven by three 12,500 HP gas turbines. Gas turbine exhaust serves as preheated air for three high pressure steam generators. High efficiency expanders provide low temperatures for maximum ethylene recovery.

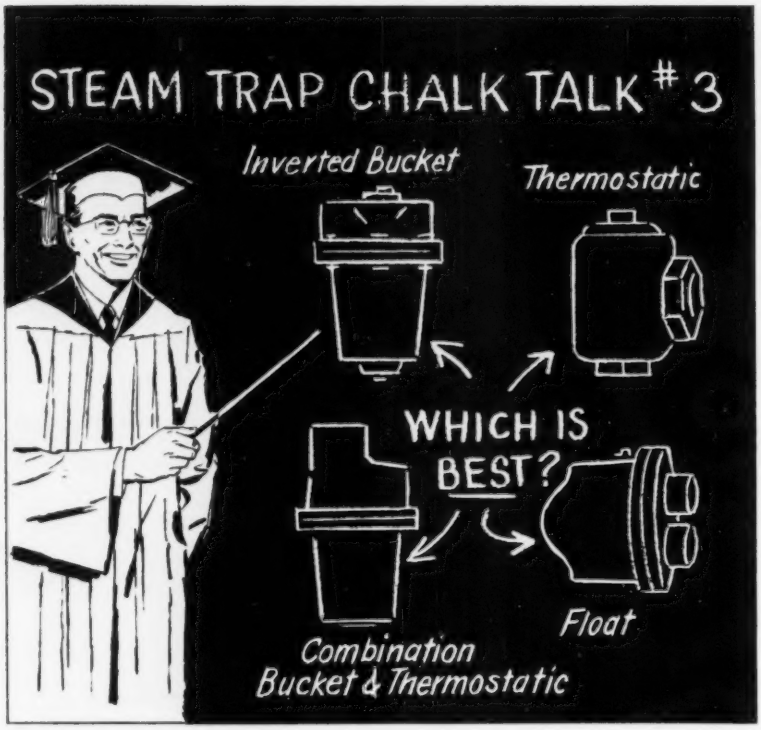
This plant brings the total of Lummus designed ethylene plants to 14, with a combined capacity of over 1 billion pounds per year.

Lummus has designed, engineered and constructed over 800 plants for the process industries throughout the world in the last 50 years. Why not discuss your next project with a Lummus representative.

THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, N. Y., Houston, Washington, D. C., Montreal, London, Paris, The Hague, Maracaibo. *Engineering Development Center:* Newark, N. J.

Visit The Lummus Exhibit, Fifth World Petroleum Congress Exposition, New York Coliseum, June 1-5, 1959

For more data on advertised products, use Readers' Service Cards, last page.



Is one trap design better than another?

● The steam trap user is often confused by the fact that there are four different designs of traps on the market. Is one better than another, and if so, which one should he use?

Actually, each design of trap has its place, *depending upon the application*. For example, thermostatic traps are preferred for chemical, petroleum and other outdoor applications because they cannot freeze. However, they do not compare in efficiency with inverted bucket traps for normal inside use. Where fast heating up is required, the combination bucket and thermostatic trap permits steam units to reach maximum heat 2½ times faster. For continuous service, float traps are best.

For sound recommendations, ask Anderson. Manufacturing a complete line of traps, in all designs, they give unbiased counsel. Their engineering catalog, "How to Select Steam Traps and Other Fluid Specialties" contains hundreds of worthwhile recommendations. Mail coupon for your copy today.

A TRAP FOR EVERY PURPOSE

THE V. D. ANDERSON COMPANY
division of International Basic Economy Corporation
1953 West 96th Street • Cleveland 2, Ohio

Please send a copy of your new engineering booklet, "How to Select Steam Traps and Other Fluid Specialties".

Name_____ Title_____
Company_____
Address_____
City_____ Zone_____ State_____

ANDERSON SUPER•SILVERTOPS

Who's Building...

in the Free World large enough to yield condensate rich in aromatics.

The first stage, which went on stream during spring, 1957, has one-fourth the capacity of the second stage. Societe Foster Wheeler Francaise, a subsidiary of Foster Wheeler Corporation (New York), has been in charge of engineering and design, except for the sulfur plants, engineered by Ralph M. Parsons Co. Construction of the sulfur plants is being done by Societe Fouga, a French firm.

Gathering System. Diethylene glycol is used as a hydrate inhibitor, being pumped into the pipe just downstream from the water knockout. Diethylene glycol is separated from the water at the plant's entrance and regenerated by distillation at 370 F.

Corrosion control. Generally, use of alloy steels and particularly stainless steel has kept corrosion at a minimum at Lacq. Foster Wheeler found little corrosion during the first 18 months that the first stage has been on stream.

Operation. Major units of each stage are acid gas removal plant, dehydration system, sulfur recovery plant, natural gasoline plant, and catalytic reformer. The gas stream undergoes a preliminary water wash in the second stage unit, followed by an amine wash. Although the first stage unit was designed to operate on diethanolamine, to avoid COS poisoning, the second stage is designed to operate either with diethanolamine or monoethanolamine. The second-stage amine wash, now on stream, gives the stage a capacity of 2 million cubic meters daily. The water wash scheduled to go on stream later is designed to double the initial capacity of the second stage. The water wash will absorb most of the hydrogen sulfide and some of the carbon dioxide.

Foaming. In the first stage units, occasional difficulty with foaming was encountered. Occasionally, after a new well had just been connected, extraneous deposits during the cleaning period would bring iron sulfides, heavy oily matter, and other undesirable foreign substances into the stream, occasionally flooding the separators, and entering the amine wash. The prob-

For more data on advertised products, use Readers' Service Cards, last page.

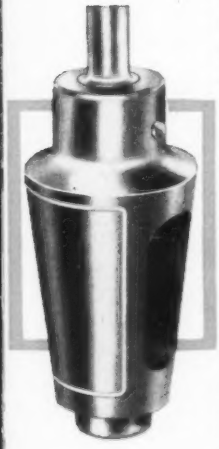
NO LEAKAGE...

You're looking at the newest thing in valves . . .

STOCKHAM'S NEW WEDGEPLUG* "O-SEAL" VALVE

Two Teflon** "O" rings in the plug give constant vapor-tight shut-off . . . to give you double assurance of double savings on operating and maintenance costs.

NO LUBRICATION!...



HOW TEFLON "O" RINGS WORK The two Teflon "O" rings are inserted in dovetail grooves machined on the face of the plug. These "O" rings seat on the raised body seats when the plug is in closed position.

CONSTANT VAPOR-TIGHT SHUT-OFF This sealing effect of the "O" rings gives absolute shut-off in all cases—shut-off that remains permanently "bubble tight." The Teflon "O" rings are chemically inert, practically frictionless, and will not cold flow.

TESTS PROVE POSITIVE SHUT-OFF

Hundreds of tests of this new valve in all types of services have failed to make it leak. Performance has been remarkable. In every case, the valve held "bubble tight" because of the pressure seal effect of the "O" rings.

OTHER OUTSTANDING ADVANTAGES

Non-Lubricated—no costly maintenance necessary • Provides Double-Block and Bleed in most services • Quick, Easy Operation—won't stick or bind • Double Seating for Double Safety—Ground metal-to-metal seat provides shut-off in case fire burns out "O" rings • No Product Contamination • Protected Seats

RECOMMENDED USAGES Stockham's new "O-Seal" is recommended for all general purposes—air, gas, water, steam, propane, hydrocarbons, etc., as well as for hard-to-hold services. Recommended for temperatures from minus 300°F to 400°F and not exceeding 720 psi.

Available in carbon and alloy steels, 2" - 12" sizes, 150 and 300 lb. pressures. Three port openings—40%, 70%, full round-wrench, handwheel, gear, and motor operated.

*Patented
**Teflon
DuPont Trademark

STOCKHAM'S NEW WEDGEPLUG "O-SEAL" VALVE

Call Your STOCKHAM Distributor or Sales Representative for complete details, or write today for the new brochure on the Wedgeplug "O-Seal."

Stockham makes a **BETTER** *valve...for* **EVERY** *job!*

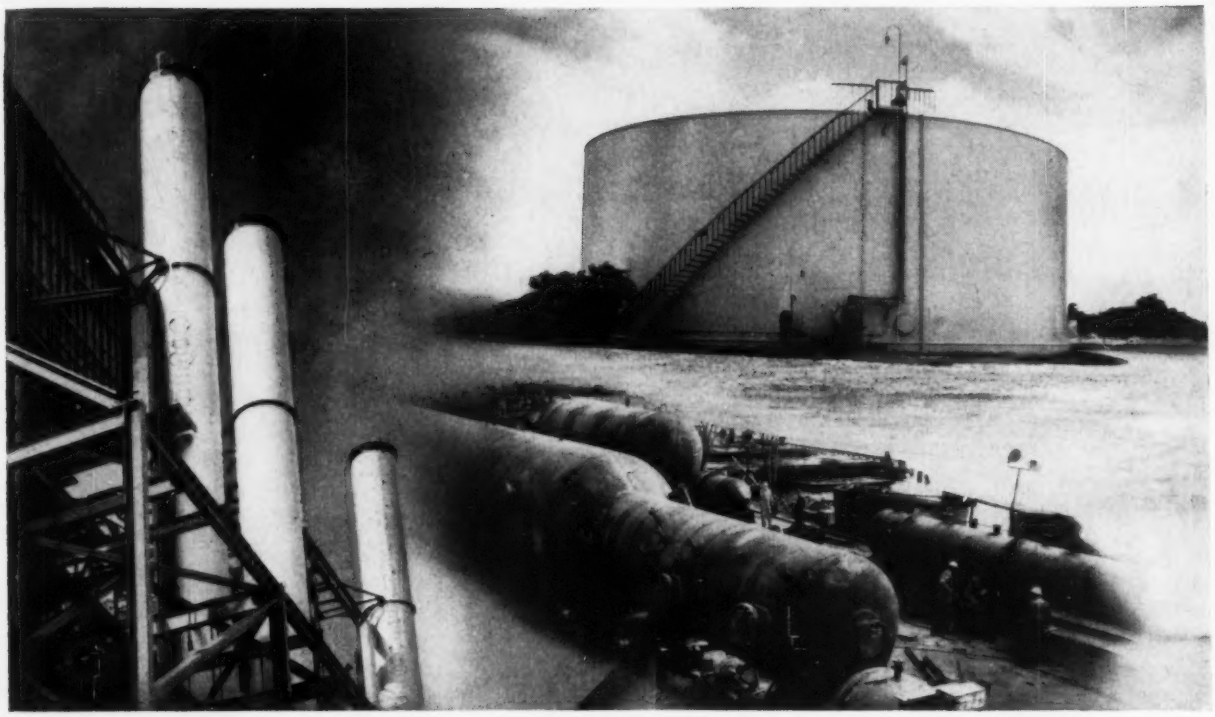
WEDGEPLUG VALVE COMPANY Division of →

STOCKHAM VALVES *and* **FITTINGS**

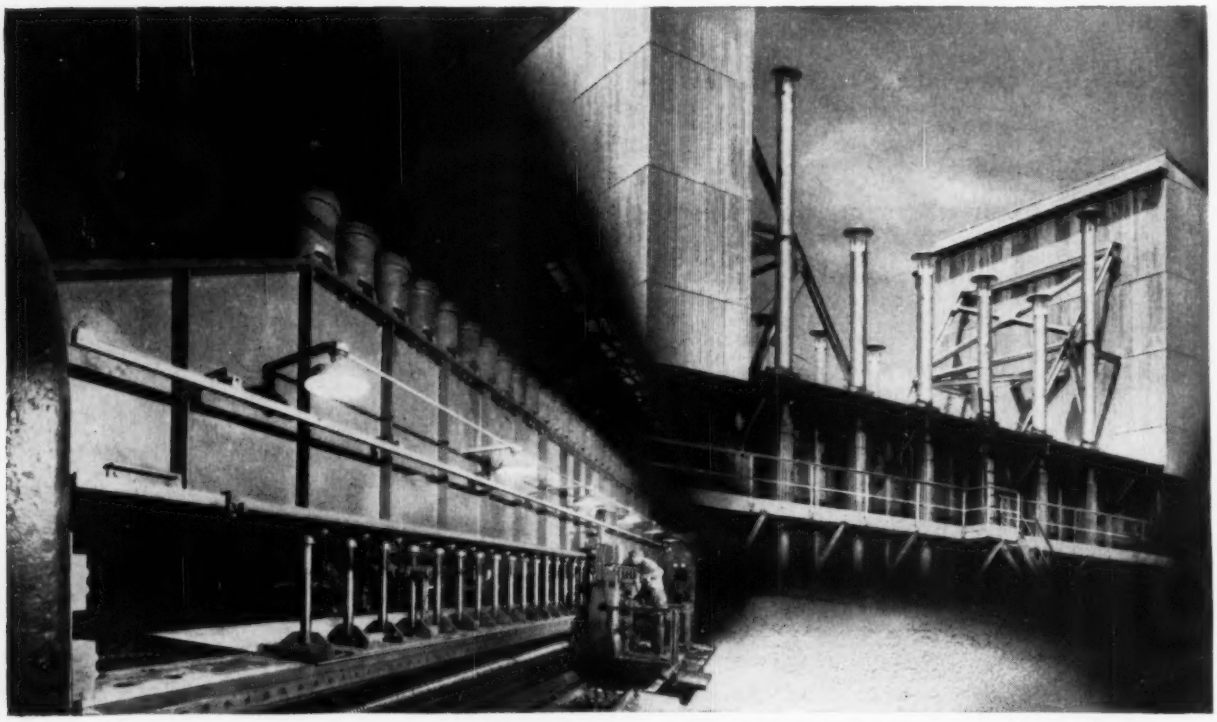
General Offices and Plant — 4003 North 10th Avenue, Birmingham 2, Alabama

CAST IRON-MALLEABLE PIPE FITTINGS • BRONZE, CAST IRON, DUCTILE IRON, CAST AND FORGED STEEL VALVES

Top-Quality



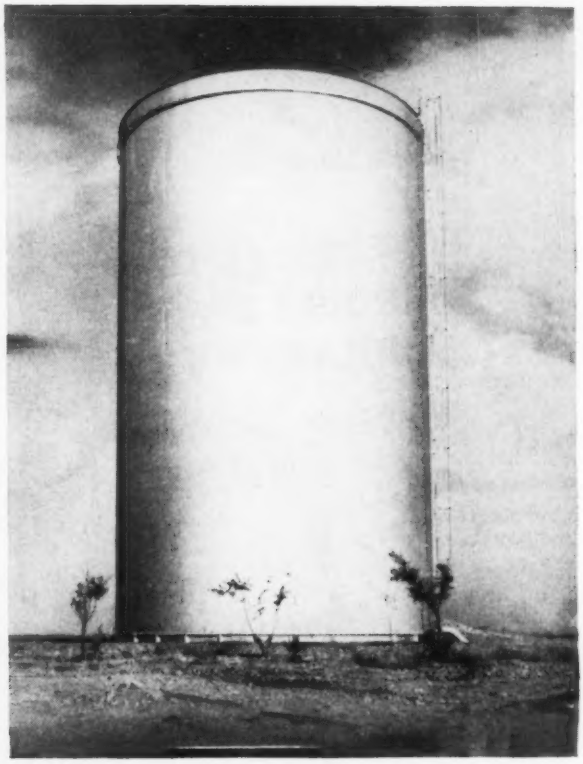
You name it, we'll make it; and erect it too!

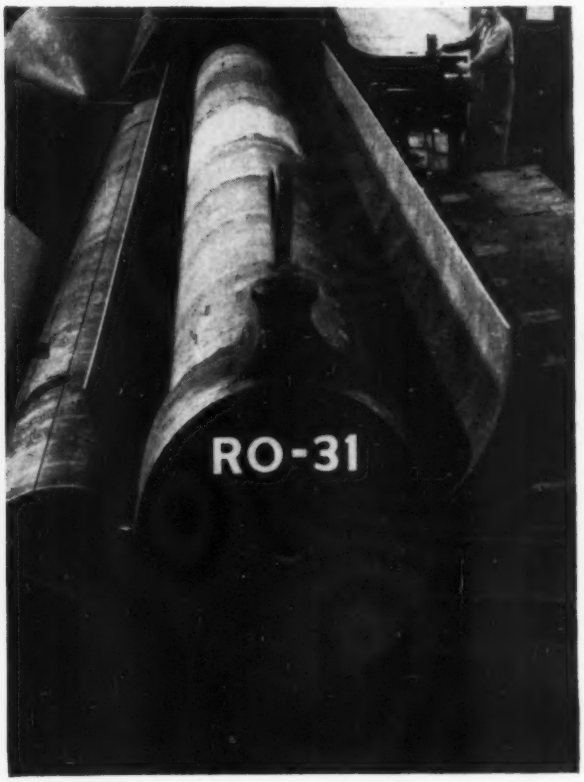


Complete, modern fabricating facilities.

Plate Fabrication

by American Bridge





OUR completely modernized fabricating plant at Orange, Texas, is now equipped to handle any type and size of custom plate work—from stacks, pipe, bins and tanks to heavy-wall pressure vessels.

And, because of its strategic location on water, rail, and truck routes, you can count on fast delivery and low shipping costs.

We are equipped to handle your plate work from start to finish—from fabrication to erection—efficiently and economically. We are also prepared to quote on any individual part of your plate requirements.

Modern facilities to handle important jobs. Our large, two-aisle building has seven cranes capable of lifting, in combined use, over 100 tons; large car bottom-heating and stress-relieving furnaces; heavy plate bending rolls; a variety of presses and press brakes; the latest in welding and X-raying equipment, plate shears, edge planers, boring mills and drills.

For top-quality plate work, get in touch with the nearest office. Or, write for our new booklet which completely describes the facilities and services available from our Orange plant.

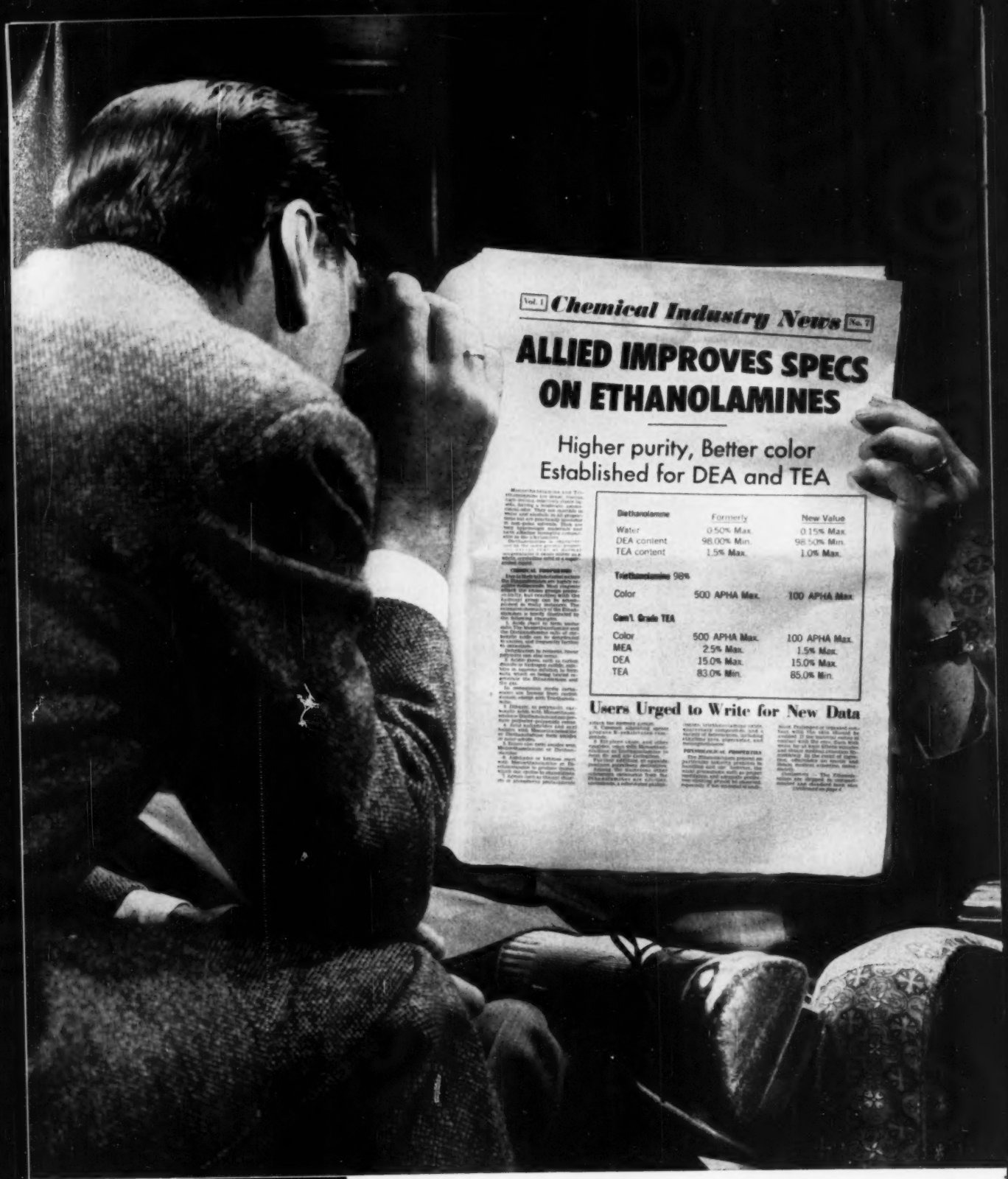
USS is a registered trademark

American Bridge Division of United States Steel

USS

General Offices: 525 William Penn Place, Pittsburgh, Pa.
Contracting Offices: Ambridge · Atlanta · Baltimore
Birmingham · Boston · Chicago · Cincinnati · Cleveland
Dallas · Denver · Detroit · Elmira · Gary · Harrisburg,
Pa. · Houston · Los Angeles · Memphis · Minneapolis
New York · Orange, Texas · Philadelphia · Pittsburgh
Portland, Ore. · Roanoke · St. Louis · San Francisco
Trenton · United States Steel Export Company, New York

For more data on advertised products, use Readers' Service Cards, last page.



Allied Chemical

NITROGEN DIVISION

Dept. EA 7-21-2, 40 Rector Street, New York 6, N. Y.

Who's Building...

lem has been mitigated by better completion methods in the case of new wells being drilled, and through use of silicone-type antifoaming agents. Such agents are, in effect, corrosion inhibitors also; so they serve a dual purpose.

The composition of the sweetened gas downstream from the amine wash in the second stage is shown in Table 2.

TABLE 2
Sweetened Gas Analysis

Constituent	Volume Percent
H_2S	0.009
CO_2	0.039
C_1	93.442
C_2	3.738
C_3	1.080
C_4	0.687
C_5	0.211
C_6+	0.052
inerts	0.330
RSH	0.302
COS	0.014
H_2O	0.076
	100.000

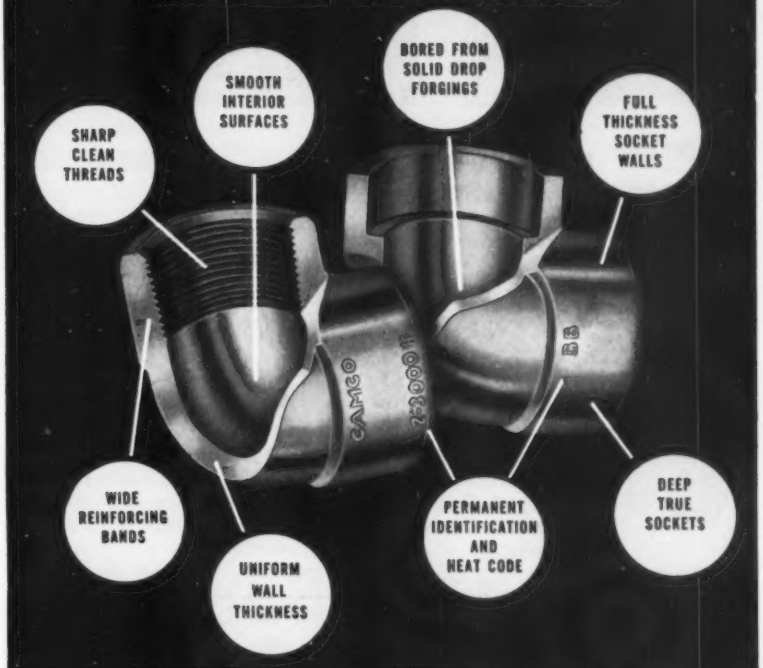
Horsepower recovery. An unusual feature of the second stage amine unit is the utilization of an expansion pump which provides recovery of about 50 percent of the horsepower output. Efficiency of the unit is already enhanced by the recovery of almost all the exothermal heat of the Claus process partial oxidation of H_2S to sulfur by air. Thus it is necessary to operate only one low pressure steam unit for the amine reboilers, with another on standby.

Final desulfurization. In the first stage unit, remaining H_2S, CO_2 and mercaptans are separated further in a double caustic wash. There is no disposal problem in the case of the spent caustic, which is sold. The second stage is expected to be more efficient for preliminary removal of H_2S and CO_2, and no secondary caustic wash will be necessary. It is possible that caustic scrubbing will not be required at all in the case of the second stage. Purity specifications for gas to be put into pipe lines are somewhat relaxed from the extremely rigid requirements involved in the design of the first stage.

Aromatics. At present, the aromatics problem is handled by bringing in paraffinic naphthas from a French refinery to absorb aromatics in the natural gasoline plant. Propane and butane are extracted, and the naphthas, enriched with the adsorbed aromatics, are sold back to the refinery. There are plans to develop a future petrochemical industry at Lacq, based on the heavy aromatics content of the condensate, but nothing tangible along this line exists now.

Sulfur recovery. The sulfur recovery units, as designed, are modified claus process plants. The first stage unit has been able

SPECIFY
CAMCO
THE Quality LINE IN FITTINGS
2000 Lb., 3000 Lb. and 6000 Lb.
SCREWED and SOCKET WELD
STAINLESS STEEL FITTINGS



Special non-standard fittings furnished to order . . . One source for all your stainless fitting requirements.

Also available—150 lb. screwed fittings and all schedules of buttweld fittings.

CAMCO FITTINGS, INC., 301 State Street
North Haven, Conn.

M&R
☐ Catalog Extra Heavy 657.
☐☐ Catalogs covering complete line. CE
☐ Furnish address of area distributor. PR

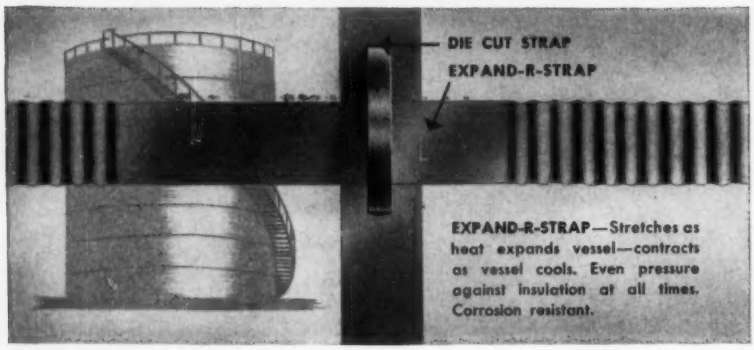
NAME_____
COMPANY_____
ADDRESS_____
CITY_____ ST._____

THE Quality LINE IN FITTINGS
CAMCO
FITTINGS, INC.
No. Haven, Conn.

WEST COAST AGENT AND WAREHOUSE
J. J. GATELEY CO.
8283 Baldwin Street
Oakland 21, California

For more data on advertised products, use Readers' Service Cards, last page.

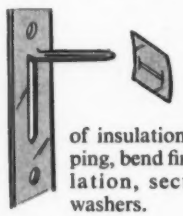
NOW! One source for ALL your strapping needs


DIE CUT STRAP
EXPAND-R-STRAP
EXPAND-R-STRAP—Stretches as heat expands vessel—contracts as vessel cools. Even pressure against insulation at all times. Corrosion resistant.

ALLOY STRAPPING
For all types of insulation and varying corrosive conditions.

TENSIONING TOOLS
A full range of highest quality—easiest to use strapping tools.

ALLOY SEALS
Stainless steel, aluminum, galvanized, brass and monel seals for all widths and sizes of strapping.



FINGER STRAPPING
For all thicknesses and types of insulation. Apply as strapping, bend fingers, impale insulation, secure with spring washers.

WIRE—STAPLES & PINS
Available in all alloy grades.

SPACERS & CLAMPS
Especially designed for steam tracer lines.

A.J. GERRARD AND COMPANY
1956 Hawthorne Court • MELROSE PARK, ILLINOIS

☐ INSULATION CONTRACTORS — SEND FOR THIS 52 PAGE INSULATION MANUAL
☐ SEND DETAILS ON FOLLOWING PRODUCTS: _____

COMPANY _____
NAME _____ TITLE _____
ADDRESS _____
CITY _____ ZONE ____ STATE _____

Who's Building...

to recover up to 94 percent of the sulfur in the original gas stream.

The acid gas stream must contain less than one percent hydrocarbons. The remaining hydrocarbons are flashed out before stripping.

Importance to France. Utilization of this large, deep, high-pressure noxious gas deposit is of great importance to the French economy. Of unprecedented size compared to the nation's other gas reserves, Lacq is expected to fulfill a large proportion of France's energy requirements, and to bring its sulfur production to second in the world after the United States, and equal to that of Mexico. A large industrial complex, involving big power, fertilizer, petrochemical, and other types of new plants, is expected to spring up in the Lacq vicinity in the future.

Cobenam, S. A., a Belgian company, has been formed by Union Carbide Corp. and the Belgian firm Societe Chimique des Derives du Petrole, S.A., Petrochim. Plans call for construction of a plant having an initial capacity of 15,000 tons of polyethylene annually, with production to commence in mid-1960. The plant site will be near Antwerp between the Petrochim chemical plant and the Societe Industrielle Belge des Petroles (SIBP) refinery.

The new installation will receive its raw material from SIBP. Technical know-how will be provided by the Union Carbide.

Monsanto Chemicals, Ltd., will erect a 15-million-pound-per-year maleic anhydride plant at Newport, Monmouthshire, England, said to be the largest constructed outside of the United States. Scientific Design Co., Inc., will handle the entire turnkey project, to be completed in the latter half of 1960.

The process used produces maleic anhydride by continuous, catalytic, vapor-phase air oxidation of benzene.

The new plant, together with existing facilities "will enable the company to supply the future demands of British industry, and also fulfill the consumption requirements of the Commonwealth and other export markets," say company spokesmen.

SunOlin Chemical Co.'s $11-million, 73,000-ton-per-year urea plant, North Claymont, Del., will go on stream by the end of the year. Construction will begin in March at the 13½-acre site adjacent to Sun's Marcus Hook, Pa., refinery, by The M. W. Kellogg Co. The Fauser-Montecatini process will be used, in which liquid ammonia and carbon dioxide gas are reacted at 3,000-psi and 370 F to form ammonium carbamate, which then decomposes to urea and water. There will be a complete conversion of ammonia and carbon dioxide to urea.

Urea is produced as a water solution. This is evaporated and most of the resulting molten urea is "prilled" into small, white, odorless beads. Prilling is

BEHIND THE NEWS

* * *

SunOlin to Build $10 Million Urea Manufacturing Plant

PHILADELPHIA — A urea manufacturing plant to be built by a newly-formed concern jointly owned by Sun Oil Co. and Olin Mathieson Chemical Corp. will cost between $10 million and $11 million, Sun disclosed here.

Sun and Olin Mathieson announced formation of the concern, called SunOlin Chemical Co. last July, and said then a plant would be constructed to make urea adjacent to Sun's Marcus Hook, Pa., refinery. A Sun spokesman said the site selected adjoins the Marcus Hook refinery but is just across the Pennsylvania border in Delaware.

The plant will have capacity to produce about 73,000 tons of urea a year, for use in making chemicals, fertilizer and cattle feed. Construction is scheduled to begin next spring.

Process by Montecatini-Kellogg!

First news release on SunOlin's new urea plant was the above announcement from the Wall Street Journal, December 23. Back of this story is that SunOlin Chemical Company will use a Montecatini-Kellogg Liquid Recycle Process, and that Kellogg will build this new 222-ton/day urea plant.

SunOlin's selection of the Montecatini-Kellogg route for its initial venture into a highly competitive market is significant recognition of the economics involved. Among the many advantages in this instance are: (1) Low initial investment; (2) Low operating costs and corrosion-free maintenance; (3) Complete conversion of the ammonia and carbon dioxide feeds; (4) High purity product, with biuret content less than one per cent; (5) Low-moisture, free-flowing prills without drying or coating operations.

Kellogg is privileged to participate in this new undertaking for SunOlin. If *you* are interested in urea, complete information on the Montecatini-Kellogg Processes may be obtained by writing Kellogg's Contract Sales Division for its recent brochure.

THE M. W. KELLOGG COMPANY

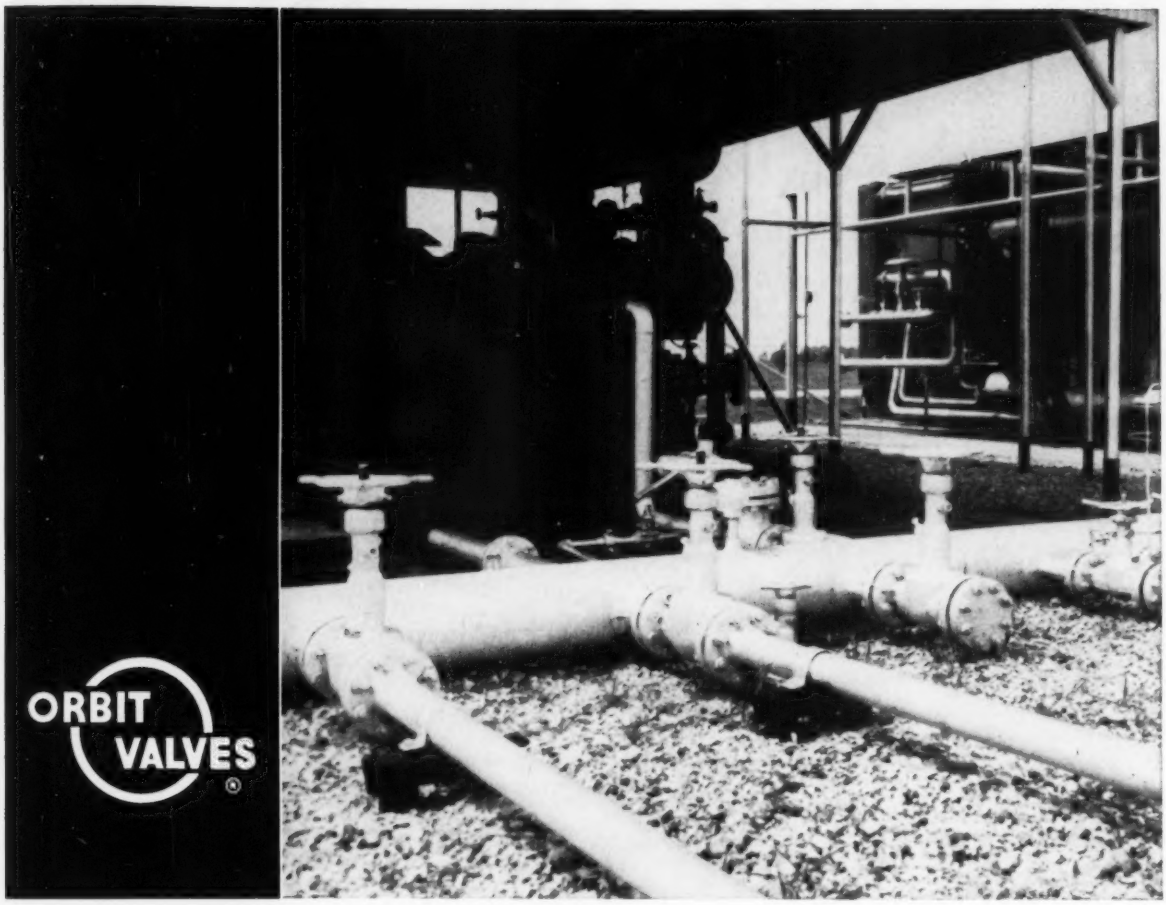
711 Third Avenue, New York 17, N. Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Co., Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York • Societe Kellogg, Paris • Companhia Kellogg Brasiletra, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

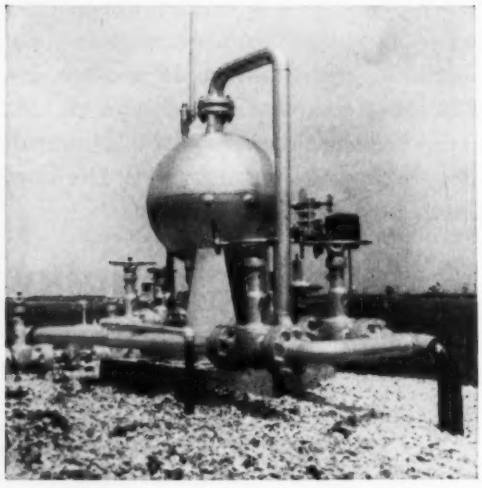
For more data on advertised products, use Readers' Service Cards, last page.

QUALITY AND RELIABILITY AT WORK



ORBIT FORGED STEEL VALVES ARE NON-LUBRICATED

and built for continuous heavy-duty service



Orbit valves shown in picture at top are installed in compressor discharge service. This is a tough service where velocities and vibration would play havoc with most valves — but not with Orbit valves, because they are built to withstand continuous heavy-duty service.

WRITE FOR CATALOG 58-B COVERING ASA CLASS VALVES OR CATALOG 58-A COVERING PRODUCTION VALVES.

ORBIT VALVE COMPANY

P. O. BOX 699, TULSA, OKLAHOMA, Phone LUther 4-4761, TWX TU 925
WAREHOUSES: HOUSTON, TEXAS, 407 Velasco, CApitol 8-6623, TWX HO 115; ODESSA, TEXAS, 402 West County Road, FEderal 7-2263, TWX ODESSA TEX 8706; LAFAYETTE, LOUISIANA, 3111 Cameron St., CEnter 4-3326; CASPER, WYOMING, 414 South Elm Street, Phone 2-1324; EDMONTON, ALBERTA, CANADA, 7119-104th St., Phone 391-283. WEST COAST REPRESENTATIVES: Charles Lowe Company, 383 Fourth Street, San Francisco, Calif.; Marshall E. Niedecker Company, 2785 Cherry Ave., Signal Hill, Calif. CANADIAN REPRESENTATIVES: T. R. Pickford & Company, Ltd., Calgary, Alberta, 309 7th Avenue West; Amherst 2-7371. EXPORT REPRESENTATIVE: New York 36, N. Y., 500 Fifth Avenue, BRyant 9-2236.

Who's Building...

accomplished by flowing the liquid urea onto a perforated plate from which it falls as droplets down a tower against a rising stream of air. This cools and solidifies the urea droplets into beads.

Ammonia will come from Sun Oil Co.'s refinery. Carbon dioxide will be produced in a steam reformer, to be built in conjunction with the urea plant. In addition, the steam methane unit will produce 10-MMcf of hydrogen a day for Sun's ammonia production.

Bay Petroleum Co. has an extensive modernization program underway at its New Orleans refinery, including:

- A 2,700-bpd alkylation unit for gasoline production.
- Revamping of the catalytic cracking unit to increase capacity to about 13,000 bpd and to provide additional alkylation feedstocks. Related gas recovery facilities will be improved to increase propane recovery.
- A two-stage crude oil distillation unit to reduce operation and maintenance costs, and to obtain better product yields. It will give the plant a 33,000-bpd capacity, and will replace the crude unit now in use.

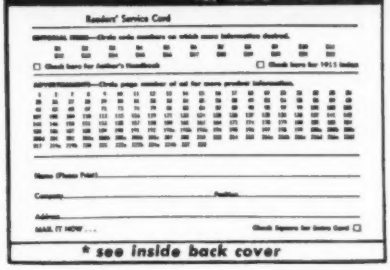
About 200,000 barrels of crude and product tankage and other facilities will also be installed. Completion is expected in early 1960.

American Chemical Corp. plans to build a $7.5-million petrochemical plant at Watson, Calif. Construction has begun and completion is scheduled for January, 1960. Products will include ethyl chloride, ethylene dichloride, vinyl chloride monomer, plastic polymers, copolymers, perchlorethylene and trichlorethylene.

The plant will go up on a site adjacent to Richfield Oil Corp.'s refinery. Raw materials will be supplied by Stauffer Chemical Co. and Richfield Oil Corp. Construction will be handled by C F Braun and Co.

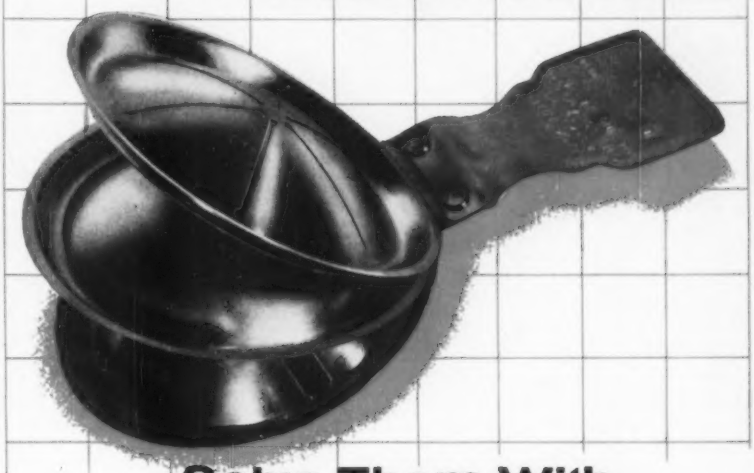
Apache Powder Co.'s explosives and chemical works at Curtis, Ariz., has installed an ammonia plant believed to be the nation's smallest. The 30-ton-per-day plant operates at direct production costs competitive with 100-ton-per-day units, says the company. Built by Chemetron Corp.'s Girdler Construction division, it

use these
READERS' SERVICE CARDS*
for more information



* see inside back cover

"Difficult" Pressure Protection Problems?



Solve Them With...

BS&B *Safety Heads!*

BS&B's D and DV Rupture Discs, which are fully interchangeable in BS&B Safety Head flanges with conventional type pre-bulged discs, are engineered to give highly desirable Safety Head protection to those pressured systems in which one or more of the following "difficult" conditions prevail:

1. When operating pressure must be close to relief pressure.
2. When high operating temperatures are involved.
3. When alternating pressure and vacuum prohibits the use of standard one-layer rupture discs.
4. When pulsating pressure conditions prevail.
5. When a combination of metal and plastic disc construction is needed to obtain lower rupture pressures.

BS&B D and DV Rupture Discs have these advantages:

1. Fast action and unrestricted relief openings.
2. Wider rangeability in selection of metals and plastics for disc components.
3. Longer service life.
4. Rugged construction for added protection against possible damage by rough handling.

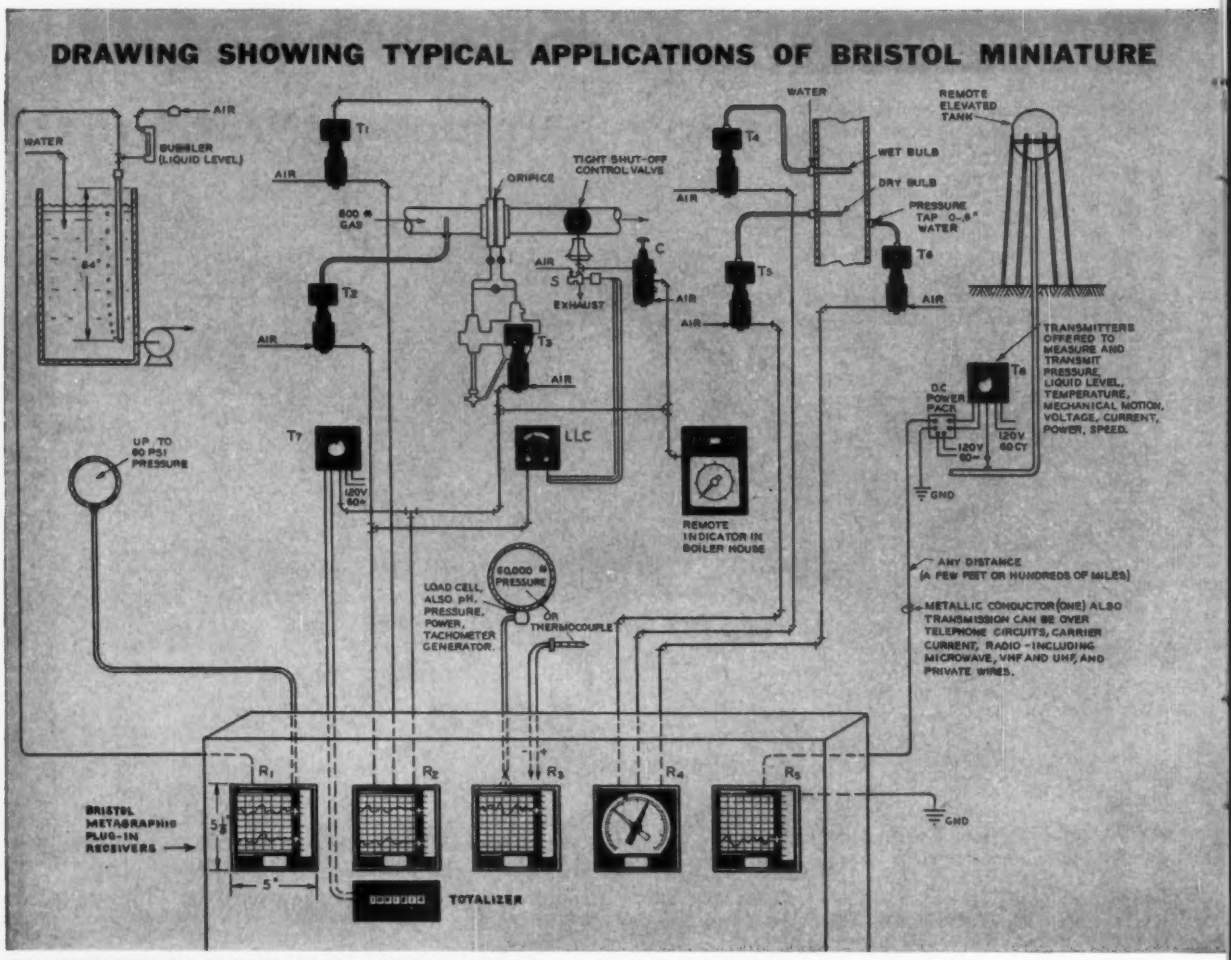
OVER 60 YEARS EFFICIENCY RELIABILITY BS&B ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

Let BS&B Safety Heads solve your pressure protection problems. Our engineers will gladly evaluate your pressure system to assist you in proper selection of Safety Heads.

BLACK, SIVALLS & BRYSON, INC.

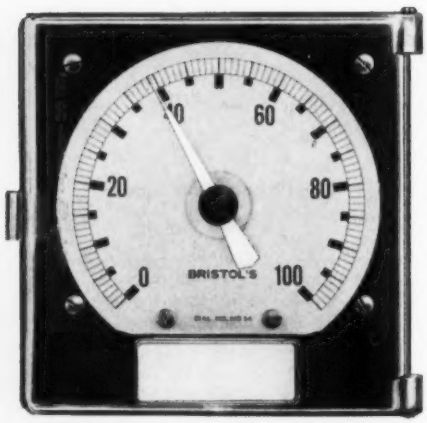
Safety Head Division, Dept. 2-F2
7500 East 12th Street
Kansas City 26, Missouri
Telephone: BEnton 1-7200

For more data on advertised products, use Readers' Service Cards, last page.



ALL RECEIVERS LOOK ALIKE ON GRAPHIC PANEL, and all take the same panel cutout (4 9/16" sq.)

Bristol offers: **More types of miniatures**



BRISTOL METAGRAPHIC INDICATORS feature easy-to-read 9-inch effective length scale and interchangeability with recorders of same type.

Bristol Miniature Instrument Systems offer broadest measurement range and widest process control coverage:

- ***Pneumatic Transmission***
- ***Electronic Potentiometers and Bridges***
- ***Telemetering Instruments***
- ***Recording Gauges***

Automatically Controlling, Recording, and Indicating Models

For more data on advertised products, use Readers' Service Cards, last page.

INSTRUMENT SYSTEMS

LEGEND

BRISTOL* METAGRAPHIC TRANSMITTERS

T_1 Pressure
T_2 Temperature
T_3 Differential Pressure or Flow
T_4 Temperature (Wet Bulb)
T_5 Temperature (Dry Bulb)
T_6 Pressure (as low as 0 to 5 mm mercury)
T_7 Integrator
T_8 Liquid Level Metameter Telemeter

*Metagraphic Transmitters are available for temperature, pressure, vacuum, differential pressure, flow, liquid level, mechanical motion, and through the use of the Bristol Dynamaster† Electronic Transmitter any input signal in the form of voltage, current, or change of resistance, capacitance, or inductance such as pH, speed, strain, density, etc.

BRISTOL RECEIVERS

R_1 Pressure or/and Liquid Level Recorder
R_2 Metagraphic Recorder (up to 2 records and 1 indicator)
R_3 Dynamaster Electronic Potentiometer or Bridge
R_4 Metagraphic Indicator—one, two, or three pointers for wide range of measurements or two pointers and one manual remote control.
R_5 Metameter† Telemeter

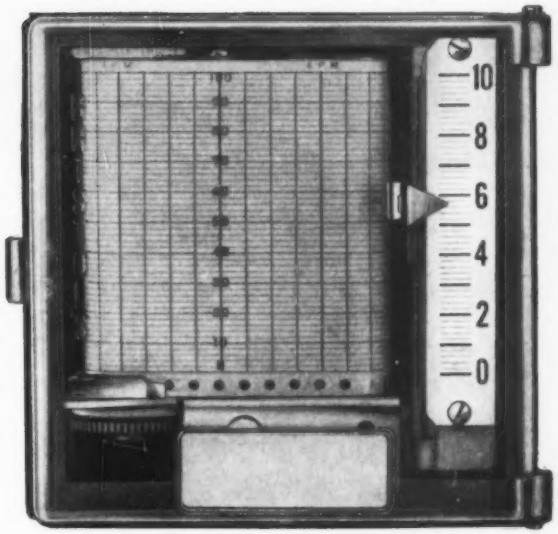
†T.M. Reg. U.S. Pat. Off.

BRISTOL METAGRAPHIC CONTROLLERS

(36 models to choose from—by far widest variety available)

Five Modes of Control

1. On-Off (Fixed High-Gain)
2. Proportional (Adjustable Gain)
3. Proportional-plus-Reset
4. Fixed-Proportional plus Fast-Reset
5. Proportional-plus-Reset-plus Derivative



BRISTOL METAGRAPHIC MINIATURE RECORDERS —whether electronic, pneumatic, telemetering, or gauge types—present a uniform, pleasing easy-to-read panel appearance, measure only 5" x 5 1/8", fit same 4 9/16" square panel cutout.

than any other instrument company

. . . plus a complete line of full-sized instruments

Bristol makes them all. Whatever your choice in instruments, you need look no farther than the complete Bristol line—pneumatic, electronic, miniature telemeters and gauges—all in a *planned* line.

Planned to give graphic panel installations a neat, pleasing, matching appearance.

Planned to give you the widest possible measurement range, the broadest instrument coverage, of any line.

Planned to free you from costly pre-installation decisions as far as practically possible—true plug-in instruments; widest practical number of instrument substitutions; easiest, fastest range changes.

Planned to give you any type of instrumentation—electronic, pneumatic or mixed systems in plug-in miniature construction.

Planned to give you the results of modern human-engineering studies in chart, dial, and indicator visibility and readability.

Bristol makes all types, all sizes of instruments, can give you all control modes. That's why Bristol application engineers don't need to shade the facts. When they make an instrument recommendation it's based on our unbiased consideration of *your* problem alone.

Write for complete technical data on Bristol miniature instruments today. The Bristol Company, 111 Bristol Road, Waterbury 20, Conn. e.e

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more data on advertised products, use Readers' Service Cards, last page.

LENAPE Weld Ends & Rings
Save You Money!

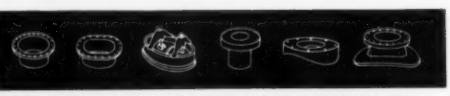
Cost conscious designers and fabricators are taking advantage of the inherent economy of Lenape forged rings and weld end connections. Specialized production techniques permit seamless forging of most alloys, including stainless—and at lower cost than other methods. Connections and manway rings are manufactured to customer specifications, and are normally furnished ready for attachment without further machining or necessity of additional reinforcement, an obvious saving in time and labor.

Lenape weld ends and rings, such as those illustrated, are widely used for nuclear power reactors, high pressure steam generators, catapult accumulators and many other modern constructions.

Find out how Lenape can save you money on your pressure vessel connections. Write for information.

See our standard line of pressure vessel connections on pages 1128-1129 in the 1958 Chemical Engineering Catalog.

LENAPE
PRESSURE VESSEL CONNECTIONS



LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 106 WEST CHESTER, PA.
RED MAN PRODUCTS

Who's Building...

employs conventional hydrocarbon reforming operations, using catalysts in producing ammonia synthesis gas from natural gas.

Sun Oil Co. has placed a $150,000 sulfur recovery plant into operation at its Toledo refinery. It converts hydrogen sulfide gas from refining processes to sulfur dioxide—then, in the presence of a bauxite catalyst, to elemental sulfur. It can recover up to 12½ long tons of sulfur a day. All combustion and reaction heat of the unit is converted into steam to supplement the normal refinery supply. It was built by Tears Engineers.

Standard Oil Co. (Ind.) has placed a new high octane gasoline plant into operation at its Mandan, N. D., refinery. The new 1,630-bpd alkylation unit is the first major addition to Mandan's gasoline-making facilities since a new Ultraforming unit was put into operation in 1956.

Yugoslavia has reportedly made arrangements with the United States for a development loan fund of up to $22.5 million to finance foreign exchange costs of a nitrogeneous fertilizer plant to be built near Paveco. Natural gas will be used as a raw material in the production of ammonia, nitric acid and calnitro.

Courtlands, Ltd. is increasing the capacity of its Spondon, England, refinery by 40 percent. Work will be completed in about a year.

Yacimientos Petroliferos Fiscales is planning an expansion of its San Lorenzo refinery, and addition of a lube oil plant. It is planned to produce 1,000 bpd of finished lube oils. A 6,000-bpd reformer will be added to the refinery, increasing production to 19,000 bpd.

Canadian Export Gas & Oil, Ltd. has completed a gas liquids recovery plant and gathering dehydration system 120 miles East of Calgary, Alberta. The 22-MMcf-per-day plant uses silica-gel in two-cycle processing towers to recover liquid hydrocarbons from the gas. Cost of all facilities was $225,000.

Shell Oil Co. is planning a 5-Mcf-per-day refrigeration-type natural gas liquids plant at the Little Creek, Miss., gas field. Capacity can be doubled later.

Deutsche Erdoel AG is planning a 40,000-bpd refinery for West Germany. The plant is slated for completion by the end of 1962.

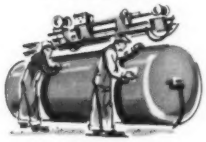
American Gilsonite Co. is planning a $400,000 expansion of its Grand Junction, Colo., Gilsonite refinery. Capacity will increase to 850 tons per day, upping output of gasoline from 1,300-1,600 bpd, and coke from 250-300 tons per day.

Warren Petroleum Corp. and Sunray Mid-Continent Oil Co. plan to build a gas products recovery plant in the Mocane gas field, Beaver County, Okla. Dresser Engineering Co. will handle construction. Design calls for 100-

For more data on advertised products, use Readers' Service Cards, last page.

Quiet...Pressure Vessels at Work

ENGINEERING



FABRICATION

FIELD ERECTION

Looks quiet, doesn't it?

Yet inside, this new refinery is pulsating with life—surging with activity to produce fuel for millions of thirsty carburetors.

And pressure vessels like those shown above are being built day-in, day-out at Solar Chicago. Meeting rigid and unusual specifications is simple for us. It's all in a day's work.

Whatever you need in pressure vessels, and whenever you need them, why not take advantage of our experience and "know-how".

We are geared to fill your needs promptly.

May we hear from you?

USI **Solar Chicago** DIV. U.S. INDUSTRIES, INC.

6400 W. 66th St., CHICAGO 38, ILL.

Telephone POrtsmouth 7-8900

FORMERLY CHICAGO STEEL TANK CO.

US RUBBER PACKING

You may be. Consider this: How much does it cost you every time you shut down a production line to replace the packing in just one piece of hydraulic equipment? Now, multiply this by the amount of times this same equipment has had to be re-packed, say, in the past three years. And multiply this figure by the total amount of hydraulic equipment in your production system.

This downtime cost is enormous—just for packing. It's far higher than the cost of the packing itself ...and a lot more than the pennies saved by buying less expensive, inferior packing.

It's for this reason that packing like U.S. Matchless® is, by far, your most economical buy. It's made in a variety of styles, each for specific applications. Used and recommended by many of the leading original equipment manufacturers, Matchless is a packing you can trust to do the job longer, better... to turn downtime losses into uptime profits.

• • •

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

US RUBBER Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

Who's Building...

Mmcf of gas daily to recover propane, butanes and gasoline. The gas will be processed for Colorado Interstate Gas Co., and will be adjacent to its trunk line in that area. Construction is scheduled to start in March, with completion slated for September.

Standard Oil Co. of Calif. is planning further expansion for its new 55,000-bpd fluid catalytic cracking plant at Richmond, Calif. The newest development, a polymer plant, is the third auxiliary unit to operate in conjunction with the cracker. Completion is scheduled for late 1959, bringing cracking-facility investment to more than $30 million.

Construction of alkylation and isomerization plants, has also been started.

Dixon Chemical & Research, Inc. is planning a major expansion at its Paulsboro, N. J., plant. It will include a 300,000-ton-per-year sludge burning sulfuric acid plant as the initial project. Construction will begin this fall.

Mississippi Chemical Corp. plans to build a $1.5-million urea plant at Yazoo, Miss. It also plans to spend $650,000 for expanded anhydrous ammonia facilities of its subsidiary, Coastal Chemical Corp. Storage facilities for anhydrous ammonia and solutions will be expanded.

Union Carbide Corp. is constructing a 15,000-ton-per-year polyethylene plant in Sicily as a joint venture with Societa Edison S.A. It will be placed in operation this year.

Yacimientos Petroliferos Fiscales has contracted with The M. W. Kellogg Co. for expansion of its Mendoza refinery from 12,000 to 40,000 bpd. Construction will last about 30 months. This will include topping facilities, a delayed coker, a cat cracker and other installations.

Canadian Oil Companies, Ltd., Canada's fully-integrated major oil company, is in the process of expanding its Sarnia, Ont., refinery from the present 30,000 bpd to 50,000.

Monsanto Chemical Co. is planning a 5,260-bpsd solvent deasphalting plant at El Dorado, Ark. Scheduled for completion in Spring, 1959, the plant will be built by Badger Manufacturing Co.

Free to PETROLEUM REFINER Subscribers

Write for free booklet on preparation of articles for PETROLEUM REFINER, the technical press generally, as well as papers for technical meetings.

Use Reader's Service green cards in the back of this issue. Write on the card "Free Author's Booklet," fill in name, address and mail. No charge, no obligation.

FREE PRESSURE VESSEL DESIGN HANDBOOK

You can establish pressure vessel specifications in just a few minutes, using this ACF Pressure Vessel Design Handbook. Conveniently arranged design data covers a complete range of pressure vessels up to 131¾" I.D. and 844 pounds psi working pressure. Step by step instructions simplify your computations. A must for everyone who engineers or purchases pressure vessels. Mail this coupon today for your FREE COPY:

Dept. PR-2

AMERICAN CAR and FOUNDRY
Division of ACF Industries, Inc.
750 Third Avenue, New York 17, N. Y.

☐ Please send me a copy of the "ACF Pressure Vessel Design Handbook".

☐ Please have an ACF Sales Engineer call.

Name _____ Title _____

Company _____

Street _____

City _____ Zone _____ State _____

acf
AMERICAN CAR AND FOUNDRY
Division of ACF Industries, Incorporated
750 Third Avenue, New York 17, N. Y.

Ferrous and Non-Ferrous Cylindrical Vessels for the transportation and storage of all pressurized commodities.

SALES OFFICES: New York • Chicago • Cleveland • Washington, D. C. Philadelphia • San Francisco • St. Louis • Huntington, W. Va. • Berwick, Pa.

for dependable deliveries of

NATURAL GASOLINE

Quality

Quantity

Service

Whatever the grade . . .
Whatever the volume . . .
WHERE you want it,
WHEN you want it, and
the WAY you want it . . .

Rely on

WARREN

WARREN

PETROLEUM CORPORATION

TULSA, OKLAHOMA • Cable Addresses: STAVOLENE, WARREN

EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN, TEXAS CITY AND WARRENGAS, HOUSTON, TEXAS, SAN PEDRO, CALIF.

What Price Professionalism?

The same as the doctor or lawyer, you as an engineer are truly a professional man. Therefore, you must constantly strive to elevate the status of your profession—and yourself

John J. McKetta, The University of Texas, Austin

YOU, THE engineer, are a human slide rule—but you are also a living and thinking human being. You are a creator and a man of imagination; and it is your vision—your ability to see better things for the future, and your personal desire for progress that will be responsible for the growth of our country.

But you are also one more thing. You are a professional. The same as a doctor or lawyer is a professional man, you too are on that same professional plane. And like the doctor or lawyer, you too should be interested in elevating the status of your profession. In short, achieving "professionalism."

Unfortunately, there are many definitions of the word "engineer," and as a consequence, it is a title frequently worn by those who are not qualified to be called such. For instance, the man who rides in the engine of a swift moving train is known as the "engineer." And in some plants, operators are known as "operating engineers" and belong to the Brotherhood of Operating Engineers Union.

I'm sure it is the hope of every engineer that in the future, the title of "engineer" will be used only by those qualified to be called such. And a good long step towards the realization of this goal will be the achievement of a feeling of "professionalism" among all qualified engineers. In other words, a feeling by all truly professional engineers that they are ready to fulfill their many obligations towards their work and their profession.

Let's take this concept of "professionalism," put it under a microscope and examine it piece by piece to see if we can find out exactly what it is; how it can help; and how it is tied in with the future.

What is Professionalism? Professionalism is to engineering as pregnancy is to human life. Either you are or you are not. There is no middle road. One cannot be only part pregnant.

The National Society of Professional Engineers' "Engineers' Creed" is as follows: "As a professional engineer, I dedicate my professional knowledge and skill to the advancement and betterment of human welfare."

Professionalism is defined in the NSPE Pledge: "I pledge: to give the utmost of performance, to participate in none but honest enterprise, to live and work according to the laws of man in the highest standards of professional conduct. *To place service before profit,* the honor and standing of the profession before personal advantage, and the public welfare above all other considerations. In humility and with need for Divine Guidance, I make this pledge."

The American Institute of Chemical Engineers' definition[1] of the professional person is an individual who, with adequate training, experience, intellectual capacity, and moral integrity, effectively devotes his skills and knowledge *to the service of society and his profession,* in whatever assignment he finds himself involved, being fully sensible of the personal responsibility and trusteeship conferred by his special training.

Notice that in both definitions there are phrases concerning "service to society" and "to his profession."

Different Opinion. Dr. Art K. Doolittle[3] gave the following list as representative of a professional attitude:

1. To be of service to society.
2. A highly professional reputation.
3. The opportunity to make progress.
4. Creative work.
5. An adequate salary.
6. Steady job.

Dr. Doolittle then gave a result of a survey of the technical employes of a large company. There were 1,300 replies received from engineers of one company, and their order of importance was as follows:

1. The opportunity to make progress.
2. An adequate salary.
3. Creative work.
4. Steady job.
5. A highly professional reputation.
6. To be of service to society.

It is serious, that even though the definitions of "Professionalism" stress "service to society," these 1,300 engineers considered it last in importance.

The AIChE published a booklet on "Professional Standards" which is available from this society without cost.[1]

Why Don't People Like Us? First, we see that engineers place "service to society" last in order of preference. Now! What do people think of engineers? A survey was made in Washington[13] on the importance of professions in the community. There were 806 respondents who were men and women ranging in age from 21 to over 60. Their education was from zero through graduate school with occupations ranging from

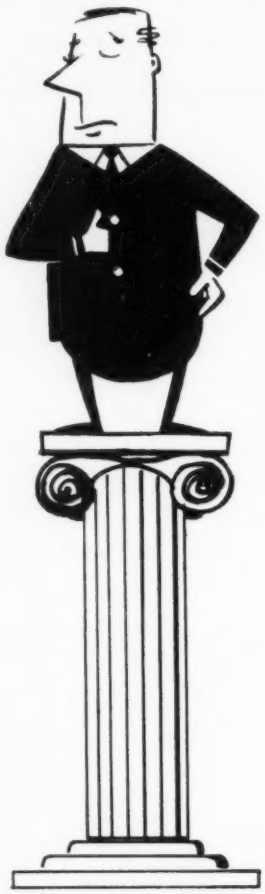
students through professional and managerial positions. Physicians were not included among professions listed in the questionnaire.

1. Which of the professions and occupations would you say requires the most education and training?
   Lawyer—34%
   Teacher—30%
   Engineer—24%
   Clergyman—13%
   Public Official—8%
2. Which of these professions and occupations do you think is the most important to your community?
   Teacher—59%
   Clergyman—13%
   Lawyer—2%
   Public Official—13%
   Engineer—3%
3. In which of these professions and occupations does the person do the most good for the people?
   Clergymen—57%
   Teacher—36%
   Lawyer—3%
   Public Official—8%
   Engineer—2%
4. In which profession or occupation is there a shortage of qualified people?
   Teacher—84%
   Clergymen—3%
   Lawyer—1%
   Engineer—10%
   Public Official—8%
5. Which profession or occupation pays the most?
   Lawyer—58%
   Clergymen—1%
   Teacher—less than ½ of 1%
   Engineer—35%
   Public Official—7%
6. Which profession or occupation has the most prestige?
   Clergymen—35%
   Lawyer—20%
   Teacher—10%
   Engineer—3%
   Public Official—26%

Should we care what people think of us? Democracy is less than 200 years old. Aristocracies stretched back into the pre-history. Perhaps we still have an anterior craving for a rigidly stratified society where the superiority of a person is established, not by natural abilities but by legally-sanctioned titles and privileges.

Americans are notoriously more impressed by foreign inherited titles than are the people of that land. For instance, why does the American public virtually lose its sanity when a motion picture star marries a distinctly minor prince most people never heard of before the engagement? The *title* and *implied superiority* makes a difference.

Now! Do you want the same people to hold you in high esteem? The



Do you want people to hold you in high esteem?

answer is, yes, of course, you do! And you must continue to do everything in your power to gain their high respect and their good feelings.

The Doctors Know. In contemplating professional problems, the medical profession is always cited as an ideal. Doctors have an unexcelled technological education; a central and unifying organization; and a code of ethics, strictly enforced, known and accepted by themselves, their clients, politicians, the armed services, and the general public.

Engineers too have a code of ethics. But not only is it unknown to the public, but it is scarcely known to themselves. Doctors have an undisputed legal status. Engineers have a legal status on the law books, but it is rejected by a majority of engineers. Doctors have a highly developed group consciousness so vital to genuine group professional status. Most important of all, they know who is a doctor and also what a doctor does. We do not even know the definition of the word "engineer."[14]

Professional recognition for engineers will always be pretty much a mutual admiration proposition. You cannot expect a housewife to admire the man that produced a more efficient engine half as much as she does the surgeon who sewed up her six-year-old son's head after he fell out of tree, or the lawyer who cleared her husband of a murder charge.[16]

People want doctors, people want clergymen; people do not want engineers. This means that during his life, the average person has an acute personal need for either the physician or the clergyman. Never does an individual have an acute personal need for an engineer! That is why, in a nutshell, the engineering profession will never be as highly regarded as the other two.

Must Earn Respect. To demand respect by the public for the engineer is an act of folly. In order to earn this respect, you must achieve it by action. You have a responsibility to yourself, to your family, to your community, and to your nation to participate in civic affairs so you may bring to bear on a problem a different insight and possibly a new solution. This is a matter for each of you to handle as individuals first and as engineers second—you cannot expect a professional union or society to do it for you.

Prestige is something you must win. You cannot buy it or automatically get it just because you are affiliated with an organization. It is something that one commands but never demands. The most the engineering society can do is encourage professional achievement and ethics. In fact, the standing of the profession is gained only from the accumulated individual accomplishments of its members.

You should admire and envy the physicians, not only for what they are today but for how they achieved this status. The American medical profes-

sion was not always what it is today. When Abraham Flexner[6] made his famous survey less than 50 years ago, the condition of the medical profession was a scandal; an incredible number of medical schools were little more than rackets, operated for the private profits of the teachers. There were no entrance requirements, no real laboratory, no library, and no definite standards for graduation. The idea was to have as many students as possible, collect the tuition fees, and divide them. Incredible? Read Flexner's book published in 1910 and his autobiography published in 1940!

Equally incredible are the methods which Flexner had to adopt to get the facts. For 3,000 years the doctors had possessed that "group consciousness" which engineers so sadly lack; even the most righteous and ethical among them were reluctant to disclose the shortcomings of their fellow practitioners to Flexner because he was not a doctor! He later received numerous honorary MD's for his service to the profession.

If you believe that your problems are too complex and too difficult to remedy, observe the vigor and speed with which the medical profession cleaned house, once the facts were laid before them.

What Does Industry Want? Engineering Professionalism, as measured by the industry, is the degree of proficiency attained by the engineer in his work, which produces results and a maximum benefit to his employer and to the public. Professionalism, therefore, includes continuing learning and exercise of judgment.

Few can deny there are gaps in experience and attitude which a young engineer must fill before he approaches high professional competence. But clearly, neither the graduate with sheep skin, nor any veteran engineer in industry should be permitted to claim professional status until he reaches and maintains minimum requirements of experience, and performance, in his field of specialization.

Industry expects engineers to produce. Industry makes a keen distinction between knowledge and accomplishment, and pays for the application of knowledge and skill to company problems.

What Can Industry Do? Industry, too, has an obligation for the advancement of Professionalism among engineers. There is a little booklet, "Criteria for Professional Employment of Engineers" available from the National Society of Professional Engineers[12] which suggests the following:

A. Salary
- **1.** Give employes better explanation of pay rate structures.
- **2.** Tie salary increases in part, to merit of work.

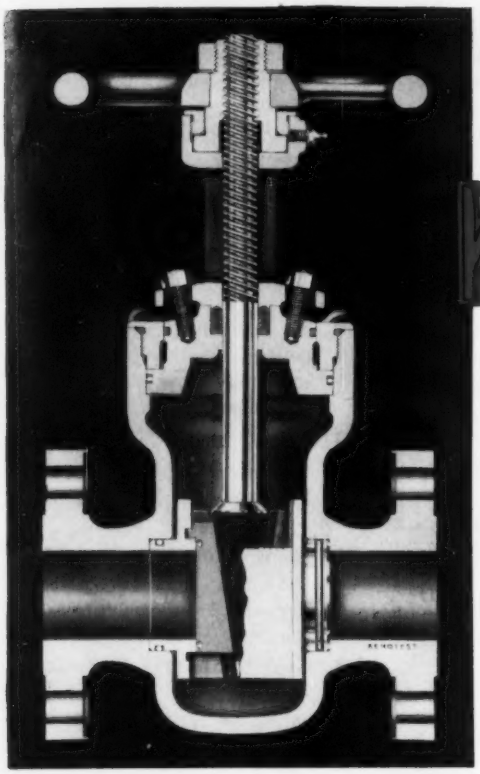
B. Assignments
- **1.** Assign tasks with greater challenge, particularly to individual workers.
- **2.** Provide opportunity to carry research and design jobs into actual operation.
- **3.** Ask less report writing on routine matters and on "dead-end" assignments.

C. Social
- **1.** Increase their contact with people and other functions and send engineers to professional meetings.

D. Treatment
- **1.** Minimize routine.
- **2.** Let technical people see ideas in operation.
- **3.** Allow chances to do creative work.
- **4.** Recognize engineers as professionals.
- **5.** Give technical people more support.
- **6.** Minimize regimentation.
- **7.** Credit individuals who do the job.
- **8.** Help individuals adjust to company ways.
- **9.** Let engineers present papers outside the company.
- **10.** Let engineers publish.

In order for the engineering profession to make a maximum contribution to society, engineers and employers must cooperate to establish a climate in which engineers can assume

Prestige is something you must win. You can't buy it or automatically get it.



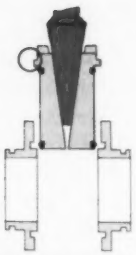
Eliminate those costly leaks...
...with the

KEROSEAL® VALVE

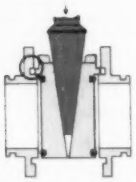
- **bubble-tight**
- **non-lubricated**
- **optional flow**
- **full opening**
- **double block and bleed**

Handles a wide range of liquids and gases in the Petroleum and Petrochemical Industries.

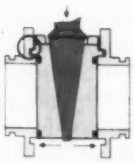
A bubble-tight seal—among other exceptional features—makes the revolutionary KEROSEAL valve an important asset to the gas, petroleum and chemical industries. This seal, effected mechanically and without the use of lubricants, eliminates wear, frictional drag, wiping and consequent galling of seating surfaces. All standard types of operators may be employed, whether handwheel, gear or motor. Write for the KEROSEAL valve bulletin for more information on this versatile new valve.



Valve fully open. In closing, discs and spreader move down, perpendicular to flow.



Discs are positioned without drag across seat. When disc lug rests on seat ring, continued downward motion of spreader moves discs parallel to flow.



Valve fully closed. Spreader holds discs bubble-tight against seat rings. When opening, seated discs are retracted with the same parallel motion – again with no drag against seating surfaces. The upward motion does not begin until discs are clear of seat ring.

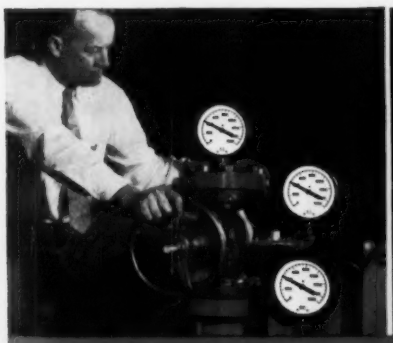
KEROTEST

KEROTEST MANUFACTURING COMPANY

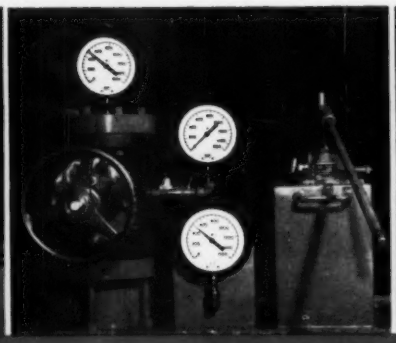
2514 Liberty Avenue, Pittsburgh 22, Pa.

In Canada, Kerotest products are manufactured and distributed exclusively by Guelph Engineering Company, Guelph, Ontario.

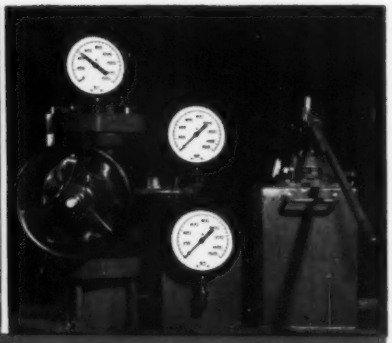
Demonstrating effectiveness of upstream and downstream seating on KEROSEAL Valves—with end flanges blanked and valve fully opened—pressure built up (hydraulic oil)—Figures 1-2-3 follow.



The valve was closed, resulting in three separate pressure chambers; i.e., body cavity between seats and two port cavities.



Pressure released in body cavity (center gauge now reads zero). Pressure remained constant in each port cavity.



Pressure released from bottom port cavity of valve. Top port cavity remains at constant pressure.

professional responsibilities and obligations.

In other words, Professionalism is a two-way street:

1. Are you a professional?
2. Is your company a professional company?

You can control yourself, but you may have trouble changing your company's attitudes and methods. Sometimes you may have to change companies.

What Can The Engineer Do? You, the engineer can grow both technically and personally.

For technical growth you should:

1. Strive to understand the fundamentals.
2. Strive to be discriminating in what you learn.
3. Avail yourself of additional training.
4. Participate in technical societies.

What can be done about technical growth at college to further professional advancement in industry? We must first recognize that the requirements in industry are not the same as in the University. In industry, we must be more discriminating in what we learn. At the University, we were expected to digest thoroughly and remember each subject encountered and exposed to.

For personal growth:

1. Learn how to get along with others.
2. Learn to express thoughts clearly.
3. Work efficiently.
   - **a.** Plan your work.
   - **b.** Do it now.
   - **c.** Do the hardest jobs first.
   - **d.** Use other aids—dictation, statistics, etc.
4. Plan shortcuts.
5. Be diligent.
   - **a.** Make the job harder to avoid complacency.
   - **b.** Make schedules, promises.
6. Learn how to sell your ideas and results.
7. Be reliable.
8. Regard your personal integrity as one of your most important assets.

The Second Mile. Some while back I watched a show on television about how the representatives of all the countries got together to try to set up laws which would finally give us everlasting world peace. All suggestions were coded and placed in a large

Are you a professional?

computer. Finally the button was pushed, and the rules which would produce ever-lasting peace, started coming out of the machine.

1. Honor Thy Father and Thy Mother.
2. Thou Shalt Not Steal.

And there were eight others.

In a very similar manner, after studying a lot of the literature on "professionalism," and after reading, re-reading, abstracting, cutting and separating all these thoughts, I found that this had all been done before. Dr. W. E. Wickenden, President of

Unions stiffle our efforts

Case Institute of Technology, until his death, covered all of these suggestions in his excellent paper, "The Second Mile" which he delivered for the Engineering Institute of Canada, in 1948.[17] This paper is now available from the Engineers' Council for Professional Development and should be required reading of all engineers, young and old.

Taking his text from the Sermon on the Mount, "Whosoever shall compel thee to go one mile—go with him twain," Dr. Wickenden goes on to say:

"Every calling has its mile of compulsion, its daily round of tasks and duties, its standard of honest craftsmanship, its code of man-to-man relations, which one must cover if he is to survive. Beyond that lies the mile of voluntary effort, where men strive for excellence, give unrequited service to the common good, and seek to invest their work with a wide and enduring significance. It is only in this second mile that a calling may attain to the dignity and the distinction of a profession."

The first mile can be considered the foundation or basic requirement[5] and includes:

1. Acquisition of superior education and training.
2. Demonstration of ability on the job.
3. Obligation to client or employer.
4. Acceptance of legal responsibility.

The second mile is the essence of a profession. Contained within this second mile is "Professionalism" itself.

1. Obligation to his profession.
2. Participation in public affairs.
3. Protection of the public interest.
4. Acceptance of moral responsibilities.
5. Ministration to humanity.

What Can Technical Societies Do? A technical society furthers the information and work of a profession by meetings, journals, fellowships, sponsorships of symposia, and similar functions. A most serious failure has been the lack of group consciousness among engineers. Why do less than one-third of all practicing engineers in the U. S. belong to any of the engineering societies? Why do so few of those who belong take an active part in the affairs? Why do we have only a handful engaged in furthering the professional aspects of engineering? Do you know that less than 20

ercent of the eligible chemical engineers are members of the AIChE?

Why should you be a member of a society? I do not recall that I have ever known a single person who has stood high in his profession or his business who has not actively affiliated himself with organizations, attended meetings, and read magazines concerned with his affairs. These seem to be the only ways in which people keep up-to-date and alert in the things which are going on.

I would not trust myself or a member of my family to the care of a physician who does not belong to a medical association, who does not read professional journals, nor goes to professional meetings. I should equally dislike to think of my child as being taught by a teacher who does not have sufficient interest in her work to secure the information and inspiration that comes from such activities.

What About Professional Unions? The National Society of Professional Engineers published a book in 1955, "The Professional Look at the Engineer in Industry."[11] Much of it discusses the professional union.

The professional man is essentially an individualist—he is a college man, highly trained, intelligent, capable of making his own decisions, rising, falling, or standing on the basis of his own individual ability, imagination, effort, initiative, and accomplishments.

Basically, much good is possible through a good union, and certainly it is sound for engineers in a mass employment situation to form councils for the improvement of their welfare. However, the principles of professionalism and the principles of unionism are diametrically opposed. They cannot integrate without one losing its identity, and by the very nature of the situation the loss would be professionalism.

Measure of Success. Joy in one's work is the prime requisite for a truly successful career in any field. It is unfortunate that there are thousands of engineers who find the earning of their daily bread an eight hour per day prison sentence, even when financially rewarding.

Fortunate, indeed, are you and I and the men who have professions which are constantly opening new fields of understanding which can result in concrete evidence of something contributed to the world.

The last of our rich endowments are the knowledge of and a challenge to the great accomplishments the future holds.

Do you want to strangle the self satisfaction and joys by working within the ranks of unions?

I have mentioned earlier Dr. Wickenden's classical "The Second Mile." The professional union can very well fulfill all the requirements of the first mile, but read again "The Second Mile." "Beyond that lies the mile of voluntary effort, where men strive for excellence, give unrequited service to the common good, and seek to invest their work with a wide and enduring significance. It is only in this second mile that a calling may attain to the dignity of the distinction of a profession."

Professional unions can hamper and stifle your efforts toward the second mile. They can put a ceiling on your work and initiative.

If you are satisfied to go only the first mile, the professional union can be for you. If you want to go the whole way, you can *only* do it on a personal basis.

Your Future. You, the engineer of today, will share in the shaping of the world of 1999. It is inevitable that industry will be extended on world wide lines rather than on the present country wide level. Production and research problems will be along more fundamental basis than at present.

You will be included in any field which requires the application of science, the consideration of economics, the systematic organization of efforts. The fields will be so varied that your efforts will have to be combined with those of the workers of the agricultural, medical, banking, underwriter, and many others. This will call for teamwork rather than the usual self sufficient profession. You will have to bear much heavier responsibilities in the civic and economic affairs; your job will be so varied, and will change so fast that today you are completely unprepared with your once-thorough education which you received yesterday.

Can Professionalism help *you* in the future? What is Professionalism? What are the professional obligations? Must you be a professional? Is Professionalism your responsibility, or is it the responsibility of industry? I hope that this article has given you some of the answers.

LITERATURE CITED

[1] American Institute of Chemical Engineers, 25 W. 45th Street, NYC, 36, N. Y. "Professional Standards," 8 pp. 1955.
[2] Brown, Bonner and Weir, "The Next 100 Years," Viking Press, NYC, 22, (1957).
[3] A. K. Doolittle, "Essential Characteristics of Professional Conduct," Carbide and Carbon Chemicals Corp., So. Charleston, W. Va.
[4] G. A. Dyer, *Texas Professional Engineer*, Feb., 1958, p. 16.
[5] C. H. Evans, Speech to Delaware Society of Professional Engineers (Bos. 1848, Wilmington) April 2, 1954.
[6] A. Flexner, "Medical Education in the U. S. and Canada," 1910.
[7] R. P. Genereaux, "Engineers and Engineering," E. I. duPont de Nemours, Wilmington, Del.
[8] H. R. Hyder, "You Never Had It So Good," The Bent of Tau Beta Pi, Feb., 1958, p. 20.
[9] W. J. King, *Mechanical Engineering*, May, June, July (1944).
[10] Alfred Neuman, E. Mad., May, 1958.
[11] National Society Professional Engineers (2029 K Street, N. W., Washington, 6, D. C.), "A Professional Look at Engineers in Industry," 1955, 123 pp.
[12] NSPE, "Criteria for Professional Employment of Engineers," 1956, pp. 23.
[13] Northwest Professional Engineers, Dec. 1956, p. 18-19.
[14] W. F. Ryan, "A Survey of the Engineering Profession," *Mechanical Engineering*, Nov., 1957, p. 1036.
[15] W. Shearon, *Ind. Eng. Chem.*, 28, 3487 (1950).
[16] N. C. Undegraff, *Chem. Eng. Progress*, 53, March 8 (1957).
[17] W. E. Wickenden, "The Second Mile," Engineers' Council for Professional Development, 29 W. 39th Street, NYC, 18, 14 pp, 15 cents.

About the Author

John J. McKetta is chairman of the Chemical Engineering department at The University of Texas. A member of numerous professional societies in his field, and active on many national committees, he is a national director of AIChE, member of the board of regents of Tri-State College, member of the board of directors of five companies, and is an active consulting engineer. Dr. McKetta is chairman of the editorial committee of PETROLEUM REFINER, and was its editorial director from 1952-54. He has written more than 50 technical articles, many chapters in various technical books, and is co-author with Dr. K. A. Kobe of an outstanding series of books on "Advances in Petroleum Chemistry and Refining." He has a B.S. degree in chemical engineering from Tri-State College, and M.S. and Ph.D. degrees from the University of Michigan, and both schools have honored him with the title "Distinguished Alumnus." Dr. McKetta spent five years with Wyandotte Chemical Co. in the Technical Service division, and as superintendent of the Caustic Soda division. He was chemical director of the C. B. Schneible Co. before pursuing graduate studies, and is a registered professional engineer in Texas and Michigan. This article is based on speeches Dr. McKetta has presented to numerous professional groups throughout the United States.

Did you ever ask for engineering design data on heat exchangers and then have to wait a week or two to get the information? Exasperating, isn't it? Now thanks to the Brown electronic computing system, heat exchanger quotations, specifications and recommendations are sent out overnight. Heat exchangers are sized accurately with optimum design efficiency for the majority of duties in a matter of minutes.

If you design or buy heat exchangers, send for Brown's heat exchanger data sheets prepared especially for its electronic computer. It takes only a few minutes to fill out the design data required on these handy-to-use forms. Mail to Brown Fintube. In a matter of minutes an accurately sized exchanger and specification is on its way back to you!

Send for Brown's Heat Exchanger* ELECTRONIC COMPUTER *Data Sheets

BROWN FINTUBE CO.

304 HURON STREET • ELYRIA, OHIO

Telephone: FAirfax 3-3291

Gentlemen:

Please send me a set of your electronic computer data sheets without obligation.

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

Safety Saves Insurance Dollars

You have to have plant fire and explosion insurance—but here is how you can keep the premiums to a minimum

K. C. Loomis
Blaine and Company, Houston

AS INSURANCE is a virtual requirement in this modern age, its cost is of vital importance. The best time to consider this is before the plant is erected as certain safeguards and protection should be incorporated in the original design.

One of the prime objectives of the designer is to achieve the most efficient operation for the capital invested. However, the savings in insurance costs over a period of years may justify additional expenditures for safeguards and protection. There should, therefore, be no conflict between the design for efficient operation and minimum insurance cost. This article will show you how a modern gasoline plant can be designed to accomplish low insurance cost without impairing efficient operation and will describe how fire and inherent explosion insurance rates are established.

Setting the Rate. According to the insurance rating schedule, used in all states, certain plant features will determine the applicable insurance rates. These features are such things as construction of certain buildings, plant layout, selection of equipment and controls and fire protection equipment.

Only the compressor buildings, products pump houses and products storage tanks with a capacity of 10,000 barrels or more, are used in computing plant rates. All other buildings and structures are subject to the rate so developed but do not enter into the computation. The insurance rating schedule is based upon the use of wholly incombustible or superior construction for the compressor buildings and products pump houses as a standard for which the basic rate applies.

If combustible materials are used in the construction of these buildings, the insurance rates are increased according to the extent such materials are used. For example, if the buildings are entirely of combustible construction the full penalty will be added to the rates. If the buildings are of incombustible construction except for combustible roof supports and wall framing or interior finishes or insulation, then a partial penalty will be applied.

Ventilation and Heating. It is important to provide adequate ventilation in these buildings. Some areas, because of moderate climate, permit the omission of walls. In other areas, adequate ventilation may be a problem, but the penalty can easily be avoided when the buildings are designed.

There must be adequate clearance from heating devices, such as boilers or other heaters and their vent stacks, to any combustible materials, otherwise penalties can be added to the insurance rates.

Loading and Storing. The loading rack for highly flammable products, such as natural gasoline and LPG, may be placed so that it becomes a threat to the compressor building, storage tanks or process area. The vapors from a spill could ignite a tank truck or tank car or they could

"Let's say, for instance, that a gasoline plant with an insurable value of $3 million has been erected in accordance with these requirements and is supplied with the necessary fire protection equipment, the annual premium would be $5,400."

"On the other hand, if the same plant violated all of the requirements and provided none of the fire protection equipment, the annual premium could be as much as $28,080."

flow into the compressor building or process area. The loading racks, therefore, should be located at least 200 feet from the compressor building and process area.

The storage tanks with over 500 barrels total capacity should be a minimum of 100 feet from the loading racks and from the compressor building. If this distance is not maintained, penalties are applied to the insurance rates and if the distances are less than 50 feet, the penalties are doubled.

When using horizontal storage tanks for products, it is good practice to install them parallel to the plant and process area and at a lower level so that in case of fire they would not be projected into the plant and vapors or liquids would not flow toward the plant. This is strictly for plant safety, however, as the rating schedule does not make a charge or allow a credit for this phase of tank construction or location.

Shutdown Warnings. It is important that the compressors be protected against possible liquid entering the cylinders from the scrubbers. To avoid a serious accident as well as a penalty, the compressors should be equipped with automatic shutdown when the liquid reaches a high level in the intake scrubbers. An automatic bleed or pump-out on the scrubbers will accomplish the same purpose.

Also, an automatic visual or audible alarm, actuated when the liquid level reaches a dangerous point in the intake scrubber, is of value where there is always someone in attendance to correct the situation. One-half the charge is made when the alarm only is provided.

Relief valves should be provided on the discharge side of the compressors arranged to relieve outside of the building, preferably to a remote flare stack or above the building eaves. If these relief valves are omitted or they release gas where it can enter the building, thereby presenting a severe hazard, a penalty can be applied to the insurance rates.

Available and Convenient. There should be valves in all incoming and discharge gas lines, so that if an accident or equipment failure occurs, all gas can be quickly shut off to minimize the hazards of fire and explosion. Also these valves must be situated so that they are convenient, yet still capable of being reached in an emergency without endangering the lives of employes. The schedule limits the distance to not less than 50 feet nor more than 500 feet from the compressor building and absorbers, without additional charge.

To avoid further penalties it is necessary that there be no open-flame devices and that all electrical equipment be of standard explosion-proof type in areas subject to hazardous vapors or liquids. Under the schedule, this includes areas within 50 feet of the compressor building and pump houses and within 100 feet of the loading racks.

The rating schedule also provides credits for fire protection equipment supplied in accordance with the following:

1. An adequate supply of approved first-aid hand fire extinguishers installed in all buildings.

2. Two-wheeled extinguishers of the 40-gallon foam, 100-pound carbon dioxide or 150-pound dry chemical types.

3. At least two one and one-half inch water hose streams supplied by 500-gallon per minute or larger pumps.

4. A foam hose system with the above water supply consisting of either two generators and 5,000 pounds of foam powder or two mechanical type foam applicators and 300 gallons of six percent mechanical foam stabilizer or 150 gallons of three percent mechanical foam stabilizer.

For Example. Assuming that a gasoline plant with an insurable value of $3 million has been erected in accordance with the foregoing requirements and is supplied with the necessary fire protection equipment, it would have an annual property damage insurance rate of $.20 or annual premiums of $5,400. On the other hand, if the same plant violated all of the requirements and provided none of the fire protection equipment, it could experience an annual rate of $1.04 or an annual premium of $28,080.

The Business Interruption fire and inherent explosion insurance rates are based upon 150 percent of the above property damage rates, so any increase or decrease affects the cost of both forms of coverage.

Management Responsibility. A well rounded fire prevention program, encompassing good housekeeping practices, through inspection and regular maintenance of plant equipment and the extensive training of employes in efficient and safe operation of all plant facilities, is an essential responsibility of plant management today. A program of this type contributes to the morale and efficiency of the employes and facilitates plant operation and maintenance. It also keeps losses to a minimum, thereby helping to maintain the present low cost of insurance.

The present insurance rates for fire and inherent explosion are based upon the past experience or the ratio of losses paid to the insurance premiums collected. If losses from fire and explosion were permitted to increase, through neglect of the fire prevention program or from any other cause, insurance costs would necessarily increase.

If, however, fire losses from fire and explosion are reduced materially throughout the gasoline plant industry, then insurance costs will be reduced.

Originally presented before the Fall meeting of the California Natural Gasoline Association, Pasadena, Oct. 9-10, 1958.

About the Author

K. C. Loomis is an engineer working in fire prevention, safety, and rating engineering for Blaine & Co., Insurance Agents, Houston. He has 16 years experience in commercial and industrial engineering in the fields of mechanical, fire prevention, safety and insurance rating engineering. Before joining Blaine & Co. he was with The Fish Engineering Corp. for five years. With Blaine for six years, Loomis attended Western Michigan College, the University of Michigan and the University of Houston.

As Management Sees It . . .

"Give your instruments a break . . ."

LET an instrument man make the perfect match between instruments and accessories. Your Honeywell instrument sales engineer knows your process and its controls, and which accessories are best suited to both. He can choose from a broad line of charts, inks, thermocouple wire, wells and protecting tubes.

Additional advantages gained from buying Honeywell accessories are service, economy and single-source purchasing. No shopping around. No need to "mix breeds." And you can be sure that whatever you buy will be right for the job. Your Honeywell instrument sales engineer will see to that. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Here's one product from the complete Honeywell accessories line:

CAST IRON T/C PROTECTING TUBES

This is one of the protecting tubes recommended for use with molten aluminum or die casting applications. It can be used at maximum temperatures of 1300° F. in oxidizing atmospheres, and 1600° F. in reducing atmospheres. Available in standard lengths of 12, 18, 24, 30 and 36 inches.

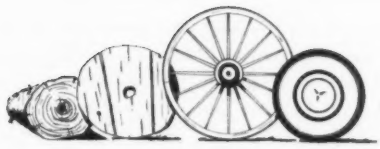
All Honeywell cast iron protecting tubes are Beta-gage checked for uniform concentricity . . . assuring maximum life.

Honeywell

H HONEYWELL First in Control

ideas out cheaply, rapidly, and ahead of the expensive

everything you observe and the study of methods of



How to Invent: Part 7

Footnote to Invention

Here's what you should know about developing a philosophy for inventing, selling or licensing your invention, starting your own company, testing your ingenuity quotient, and several other important items

Forrest E. Gilmore
Independence, Kansas

IN PREVIOUS ARTICLES of this series we have covered the many different phases of learning "How to Invent." There are, however, several other important items which you need to know, and as a consequence, they are included in this, the final article of this series.

Requirements for Invention. Invention results from a combination of knowledge, ingenuity, energy and resolution. The absence of any one of these will certainly prevent you from doing any worthwhile amount of inventing, and to successfully invent you must have all four in abundance. Actually, they are greatly interdependent. For instance, without great energy and resolution you are not apt to accumulate much knowledge and without knowledge there is little ingenuity.

There are more potential inventors who fail from lack of resolution than from anything. To succeed, therefore, you must constantly bolster your resolution. The successful man diligently cultivates his own resolution by continually reminding himself of the meaning of success and how it will fulfill many of his needs and desires. For you this cultivation may take the form of planned reading about successful inventors; possibly rereading of these articles may help. Whatever it is, however, it should stimulate your desires and help you obtain habits which prepare you for inventive thought.

Visual Imagery. Ingenuity depends to a large extent on your ability to use your imagination. I have not included any special exercises for developing your imagination like you will find in some books on creative thinking. These exercises will help you develop your inventive thinking capabilities but are not as useful to inventors as to other types of creative thinkers.

Successful inventors generally use visual imagery. So, cultivate this faculty. In your usual engineering work try to sketch all your ideas in your imagination before putting them down on paper. Combine all the items in your imagination, take a look at the whole, revise it somewhat to improve its looks and effects, then take a new look at the entire idea. This procedure will not only improve your ideas, but will develop your visual imagination.

Recollection and Imagination. Let's pause here for a moment to discuss recollection with imagination. Far too many engineers use only their recollection and no imagination. In fact, some scientists interviewed by a psychologist studying the use of imagination even denied that there is such a thing as imagination—they thought they used only recollection. Actually what this amounts to is that there is so much recollection in imagination and so many mental pictures in both that there is good reason for confusing them.

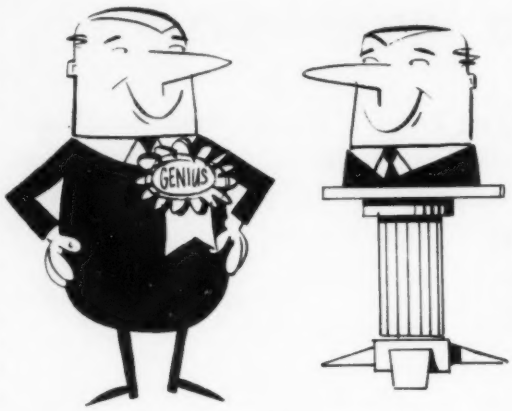
To imagine you must recollect past happenings, thoughts or sensations and combine them in your mind in a manner in which you never experienced them in real life. On the other hand recollecting you recall to mind something that really happened and a date, even though unknown, is always associated with it.

By learning to picture things and ideas in the imagination you can get a good look at them without going to the time or trouble of combining them outside the mind on the drafting board or otherwise. This permits trying

ideas out cheaply, rapidly, and ahead of the expensive and slower experimentation in the laboratory or in real life.

A Place for Standardization. While standardization of the sizes of bolts and nuts and many other items entering into the construction of complicated equipment or machines is essential for economy, convenience and efficiency, it can easily be overdone. Wrongly applied it tends to stifle innovations of all kinds as well as individualism. It takes the place of thinking and retards growth, expansion and change. Under the guise of standardization the task of making decisions and judgements is avoided and supervisors escape their responsibilities by blindly following the regulations of the company, department or industry. Engineers tend to become only store houses of rules, regulations and information about standardized equipment. And as a consequence, memory and conformity become the principal basis for advancement.

Men of this type, when advanced, have "know-how" but little "think-how" and are apt to initiate further unwarranted standardization under the impression of what is good in one instance or place must necessarily be good everywhere. This is not good logic. There may be fine distinctions in the applications of ideas or experiences which the truly creative thinker is ready to find and evaluate.



Learn to appreciate yourself

You may not be in position to resist over-standardization in your company or department, but you can resist it in your personal private thinking and living. Thus, keeping standardization in its place should be a part of your philosophy of invention.

Develop a Philosophy. Part of your philosophy of invention should be an appreciation of your own mind. Without the human mind and its capacity to receive, store, recall, combine, compare and analyze things, experiences and ideas, to evaluate similarities and to integrate parts into wholes by the use of imagination, all the laboratories in the world would be useless. Every part of you functions through your mind. It is your connection to reality. It controls your well-being. So naturally, the better it is trained the more it can do for you.

You can train your mind by feeding it with keen observation of your environment, with studied comparisons of things and ideas and with systematic and constant practice of your imagination. Learn all you can about your mind and how to use it efficiently. Remember, though, that no two minds are exactly alike; yours is unique and it belongs to you exclusively. Use it uniquely and it will respond to your benefit.

Read Science Fiction. Another part of your philosophy should include the habit of mental speculation concerning everything you observe and the study of methods of speculative thought. This philosophy should prompt you to read speculative scientific fiction which will stretch your imagination and give you relaxation and relief from conformity.

I know one highly successful scientist who is greatly respected for his creative imagination. This man carries small paper-bound editions of scientific fiction in his pocket most of the time and reads them whenever he has a few spare moments. Speculating into the future contains unlimited opportunities for you to use your imagination. To do this most effectively, however, you must keep up with the present by knowing and understanding as far as is within your capabilities, all important developments in science and engineering and their impact on society. Knowledge of the present is the basis for imagining the needs and trends of the future.

Company Acceptance. Even though you work for a large company which own any inventions you may make, if you invent you have a selling job to get it accepted. Granted, your department may have a patent administrator and the patent division of your company may have engineers whose job consists of taking patent ideas from employes and working them into patent disclosures containing sales points to be considered. However, there is no-one who is as interested in the invention as the inventor and probably no-one will study the problem as much as he. Therefore, the inventor is the one who should write up the presentation to the Patent Committee or person evaluating the worth of the invention.

I have found from personal experience that if the inventor is not interested enough in his brain child to present it clearly and explain its advantages over the conventional, its chance for acceptance is greatly reduced. In explaining these advantages try to look at it from the standpoint of your company. Therefore, along with your disclosure of the idea you should explain fully why it is better than that which is already in existence and if possible why the company needs your invention. Also, include computations and any other available data that prove the operability.

In my work as a patent administrator of a department, I tried to teach other engineers to do this and many times I added such sales items as I could to support the patent idea submitted. Apparently as a result of this, the percentage of patent ideas that were accepted from our department greatly increased. In turn the greater percentage of acceptances encouraged attention to invention and the number of ideas submitted also increased.

Selling and Licensing. It was not my intention to write about selling your own invention to another organiza-

How Is Your I.Q. (Ingenuity Quotient)?

Creative thinking creates:

1. Interest in surroundings, of others in you and in improving operations,
2. More rapid promotion,
3. Profits, and
4. Easier work as a result of increased interest.

It is believed that filling in this experimental form will stimulate your desire to excel in creative thinking and may give you some ideas to help you devise a system, suitable to yourself, which will help you on the road to success.

I. **When I relax, I purposely and enjoyably review, in my imagination, events, new ideas, new equipment and process designs, and contemplate further improvements in them.**
   a. About_____minutes per day average.
   b. On about_____days per month.

II. **When I read about something new, such as a scientific discovery,**
   a. I meditate on how I might advantageously use it. Yes____ No____.
   b. I usually make some record of it for possible use. Yes____ No____.
   c. I have a "thought file" or book for such information. Yes____ No____.

III. **Comment on this statement. The basic philosophy of presently highly advertised scientific business management is "that if one has a highly effective system, intelligence is not so necessary." Is this true regarding creative thinking?_____% true.**

Do you think you could devise a system to improve your creative thinking?_____

IV. **Do you enjoy reading "Scientific Fiction"?**___
Do you believe:
   a. "The more we know the more we are stimulated to know more"?_____
   b. Inventive creativity can be scheduled?_____
   c. Your imagination responds to what is expected of it?_____
   d. Henry Ford's greatest invention was "the assembly line"?_____
   e. That the pace of living leaves little time for reflection and thought?_____
   f. That nothing is perfect?
   g. In "Speculative Scientists"?
   h. That "Turning our thinking into the future is the test of whether we are young or old"?_____
   i. There is a technique for creative thinking?_____
   j. That free time possible through travelling or special assignment can be profitably used in creative thinking?_____

V. **Rate your interest in the following questions about any new process or device 1, 2, 3 etc. in order of interest.**
   a. What is new about it?_____
   b. What scientific principles are involved?_____
   c. How is it used?_____
   d. Is it an improvement of a well known process or device?_____
   e. How is it constructed?_____
   f. Why was it built or invented?_____
   g. Will it sell profitably?_____
   h. How can it be improved?_____
   i. Its effect on industry?_____
   j. Its effect on society?_____
   k. Its effect on you?_____
   l. Will it create a demand for something you might invent or otherwise profit from?_____

VI. **Has studying this form caused you to think about things you normally overlook and do you believe such thoughts could be of any benefit to you?_____ Please explain.**

VII. **Have you any ideas of how invention may be improved in the Refining department?**

VIII. **As far as possible without identifying yourself supply the following:**
Where employed?_____
Type of engineer?_____
Years since graduation?_____
Have you submitted a patent idea in the past year?_____
Would you like to improve your creative thinking?_____

tion. However, I have received letters from readers of these articles indicating they were anxious for such information. I will discuss it briefly.

As you may well imagine, this is nearly always a difficult problem. Many successful inventors, unable to sell their inventions or license them to others, have had such confidence that they used them as a basis for going into business for themselves, manufacturing and selling the equipment covered by the invention. Sometimes the equipment is rented to the user and serviced by the inventor's organization. Many of such businesses have quickly failed and many have been exceedingly successful. Some of the latter were those of Ford, Edison, Bell and Goodyear.

One note of caution here, and that is to be wary of those organizations which prey on inventors. A common trick is to get a contract with the inventor to sell or license his invention, with or without an initial fee. Then,

the organization submits the proposal in writing to every possible buyer or user it can find. If no results are obtained within a reasonable time, the inventor gets disgusted and may attempt something himself. If he succeeds even though he did so at a greatly reduced price, the sales organization then comes in and claims its commission.

Before contracting with any such sales organization be sure to check them thoroughly, preferentially not through any references it may give; financial responsibility is no guarantee of fair dealing. Any contract submitted should be passed on by your patent attorney.

As mentioned in the previous article, you may have your patent entered without cost in the Patent Office's Register of Patents Available for Licensing. Its entry will be published in the *Official Gazette* of the Patent Office and other means will be used to call it to the attention of those who might be interested. If you do not know the most promising prospective buyers or licensors of your invention this is certainly the first step to take.

Speculating into the future contains unlimited possibilities

Your Own Company. Also, there are some companies which specialize in assisting in the development and financing of businesses based on new inventions. If you have an invention that has great promise and one you think would make a sound basis for a new company, you can find the organization of this type you think would be the best for your purpose and submit your invention. Of course, you should include an outline of the possibilities you anticipate and what help you will need. One drawback is that these organizations usually want considerable say in management, at least until they get their money back.

Patents, like gold mines of the past and more recently wildcat oil wells and uranium mines, are the darlings of the "wildcat" promoters. There are good promoters and bad promoters. Be sure before you become associated with one that he is of the good variety and that he will not involve you in illegal operations. What may appear to you as justifiable representations may appear altogether different to those who have lost their money from belief in them.

Be extremely cautious not to get into the position of a well known oil well driller I knew in the Smackover Pool many years ago who remarked one evening "Tomorrow I will either get a big well and be an honored man or be on my way to prison as a criminal." Fortunately for him the well came in.

Measure Your Inventiveness. The fact that you are still reading these articles indicates that you are interested in invention and this further indicates that you have inventive potentialities. However, as far as I know, there is no real measure of your inventiveness except the quantity and quality of your inventions. Edison gave prospective employes a rather novel intelligence test which probably indicated the general intelligence and to some extent the interests of the ones tested. Schools, businesses and the defense organizations are also using all kinds of intelligence and aptitude tests which are no doubt valuable when properly used. However, they are frequently misused.

In order to stimulate interest in invention among engineers I prepared a questionnaire which was designed more to test interest in and attitude toward invention than actual inventive ability. I had observed that those who regularly invented had a different attitude than those who did not. I distributed over 200 of these forms to engineering employes of my department with the request that they complete them and return to me without disclosing their names.

A total of 83 completed and partly completed forms were returned to me, several with patent ideas attached. The number of patent ideas submitted that month was about double the number of the previous month. This form is reproduced here. Its prime purpose was to remind the engineers to invent and to send in patent ideas. However, a study of the filled in forms showed that any person well acquainted with the inventive process could judge from them who had the proper attitude for inventive effort.

It is insteresting to note that after reading the answers on each form I could quite accurately judge whether that person had submitted a patent idea in the past year. None of those whose answers reflected impatience toward the form had submitted patent ideas in the previous year.

No doubt there are some who can improve this form; its principal weakness being that it takes an expert to evaluate the answers. However, if you will fill it out for yourself and then from the knowledge you have obtained from reading these articles rate yourself, you should be able to determine if you have the interests and attitude to invent.

In Conclusion. These articles have been written in the hope of convincing you that invention is a necessary attribute of an engineer, that proficiency in it is obtainable, and that this knowledge will help you attain greater success as an engineer. I have enjoyed writing these articles and have appreciated the many expressions of approval which I have received. One engineer enthusiastically showed me how his application of these teachings was paying off for him in increased acceptance of his patent ideas by his company. I hope there are many more in his position. ##

What's Happening . . .

. . . in the Industry

Demand Rise for U.S. Crude Is Forecast for February

The U.S. crude to be consumed or exported in February has been estimated by the Bureau of Mines at 7⅓ million bpd compared with 7½ million forecast for January. The prediction includes estimates of total gasoline demand of 3⅔ million bpd in February, a gasoline yield of 43.5 percent, and total crude runs of 8-1/5 million bpd. Crude runs for February are expected to be 85,000 bpd higher than the January expectation.

Justice Department Rapped On Antitrust Lawsuits

"The Justice Department has shown a lack of initiative in protecting businessmen's rights in private suits, as when some major oil companies in requiring their lessee and contract dealers to waive, in part, their legal rights to sue for damages resulting from their supplier's antitrust violations." This charge was made in the annual report of the Senate Small Business Committee. "As of now", says the report, "the government has not yet tested the legality of the waiver of such rights by private parties."

Texas Plant Marks Private Industry's Helium Debut

Private industry has made its debut in the helium extraction business through newly-formed Helex Co.'s Texas plant. This represents the first move to extract helium from natural gas in 25 years. Supply in recent years has come from government plants. The oil and gas industry has been hesitant to invest in helium extraction because of limited markets.

Ethyl Tells Tracer Research Findings to SAE Group

The fuel and fuel-additive diet of each cylinder of an automobile engine can be pinpointed by radioactive tracer methods, according to Ethyl Corp. By showing which cylinders are overfed and which are starved, the methods point the way to fuel savings, better performance and lower octane requirements. The company says that radioactive tracer studies of basic wear mechanisms show fuel preignition causes severe piston-ring wear in modern automobile engines.

Exhibit for IPE Hall of Science Readied

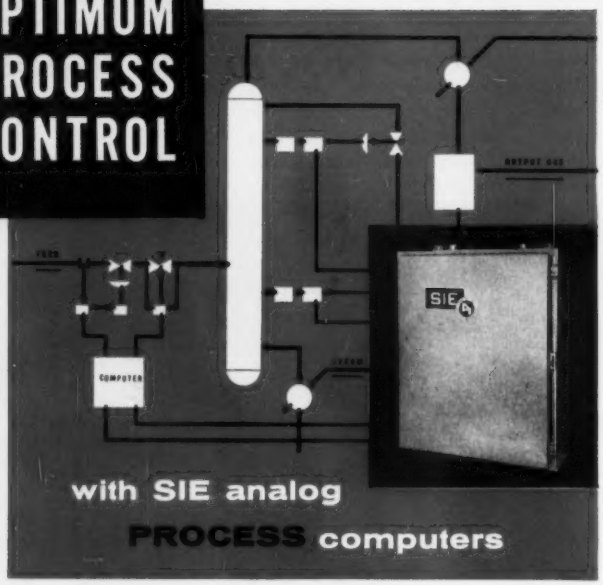
The Refining sub-committee of the Hall of Science committee, International Petroleum Exposition, has begun the process of narrowing down available exhibit material. Harry A. Brown, vice president, manufacturing, DX-Sunray Oil Co. and IPE Refining sub-committee chairman, said that his committee will pick the most deserving new process in the refining field to show to the public at the exposition. "The job will not be an easy one with all of the new processes to choose from," Brown said, "but our committee thinks the refining exhibit will be one of the best in the Hall of Science." Standing, (L to R) Brown; Bob Chesney, Kerr-McGee Oil Co.; C. D. Hull, Continental Oil Co.; H. H. Belew, Skelly Oil Co. Seated (L to R), Neal B. Prichard, Anderson-Prichard Oil Co.; Paul Williams, WPRA; Paul Buthod, University of Tulsa; Sturgis W. Darling, The Texas Co.

NGAA Permian Basin Chapter Is Formed

The first regional chapter of the Natural Gasoline Association of America has been established. At its organizational meeting, attended by more than 30 representatives of gas processing companies in the West Texas-New Mexico area, the Permian Basin chapter was officially launched under a new program of the NGAA, which authorizes regional affiliated units.

Similar chapter organizations will be sponsored in other areas where the need exists. Purpose of chapters is to provide geographically convenient technical forums for discussion and exchange of

OPTIMUM PROCESS CONTROL



with SIE analog
PROCESS computers

no ● moving parts
no ● vacuum tubes
no ● contacts

SIE CM-2 Analog Computers provide precise control in chemical, petrochemical, refining, and similar process applications, to a degree never before possible. Using this new concept, process variables are taken into account in adjusting set-points automatically to achieve optimum output yield.

Using Magnetic Amplifiers and Transistors CM-2 Series Computers have a **trouble-free life expectancy in excess of 100,000 hours,** yet in a typical fractionator application now in operation, computer cost was less than $5000.

Write for Brochure Describing Applications in Feed-Ahead, Feed-Back, and Operator Guidance computations. SIE engineers will welcome the opportunity to discuss the use of CM computers in your specialized process control applications.

SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.
A Division of Dresser Industries, Inc.
2831 Post Oak Rd. • P. O. Box 13058 • Houston 19, Tex.

PRIME AND SUB-CONTRACTORS FOR MILITARY ELECTRONICS INSTRUMENTATION AND GROUND SUPPORT EQUIPMENT

NEW... from Manzel

FLOW-actuated alarm

LUBE-LINE ALERT gives positive protection to valuable compressors, engines, machinery and other equipment using force feed lubrication. Small, compact precision-made FLOW alarm inserts into oil lines near each terminal point.

- Fits any make of lubricator
- Connects electrically to any signal—horn, buzzer, light, whistle, telephone, relay
- Signals LACK OF FLOW through line
- Flow capacities from ½ cc to 2 qts/min.
- Handles any viscosity oil or synthetic
- Pressures to 10,000 psi in standard models
- Explosion-proof units available

***FREE** Specification Sheet gives complete details. Write for your copy.*

HOUDAILLE Manzel
285 Babcock Street
Buffalo 10, N. Y.

Always FIRST with the BEST in lubrication

HOW TO SOLVE *heat transfer problems*

Here is the book to give you a quick view of heat transfer fundamentals and the calculations of applying them in the design of such equipment as feed-water heaters, condensers, boilers, internal-combustion engine cylinders, and fan coils. Emphasizes basic aspects and immediately useful calculations!

Just Published—3rd Edition

Introduction to HEAT TRANSFER

By **Aubrey I. Brown** and **Salvatore M. Marco**, both of The Ohio State University

Third Edition, 328 *pages*, 6x9, 70 *illus.*, $6.75

Engineers encountering a growing number of problems in this field will appreciate the directness of the treatment. Third edition includes new chapters on fluid flow in the convection process and graphical and numerical methods applied to heat conduction problems.

Chapter Headings

1. Modes of Heat Transfer
2. Heat Transfer by Conduction
3. Equations for the Calculation Conduction of Heat Transfer
4. Radiation
5. Fundamental Units and Dimensional Analysis
6. Fluid Flow in the Convection Process
7. Forced Convection
8. Free or Natural Convection
9. Heat Transfer to Boiling Liquids
10. Condensing Vapors
11. Over-all Transfer of Heat
12. Applications of the Principles of Heat Transfer to Design Problems
13. Transient Conduction
14. Graphical and Numerical Methods for Heat-conduction Problems

The Gulf Publishing Company
P. O. Box 2608
Houston 1, Texas

What's Happening . . .

ideas within the gas processing industry.

Membership in regional chapters is open to those connected with gas processing or utilization, including representatives of supply and service companies.

Officers of the Permian Basin chapter are: chairman, John E. Springer, Tidewater Oil Co.; vice chairman, E. T. Cotham, The Atlantic Refining Co.; secretary-treasurer, H. L. Hensley, Humble Oil & Refining Co. All are from Midland, Texas.

Named to the chapter's executive board were: J. L. Hackney, Humble Oil & Refining Co.; Charles Sweeney, Reef Fields Gasoline Co.; E. R. Wagner, Pan American Petroleum Corp.; J. L. Brown, Shell Oil Co.; Meade Corley, Phillips Petroleum Co.; Earl Palmer, The Atlantic Refining Co.; Jack Jamison, Superior Oil Co.; and G. E. Kendrick, El Paso Natural Gas Co.

L. A. Plants Plan to Use Natural Gas in Smog Months

Los Angeles refineries and power plants have agreed to burn natural gas in place of fuel oil during the smog-plagued summer months. Under the plan, the Air Pollution Control District will provide advance notice of heavy smog forecasts to the Western Oil and Gas Association which will, in turn, notify the firms to make the change-over.

Turbine Engine Saves Fuel, Chrysler Study Shows

A gas turbine engine with a good or better fuel economy than today's passenger-car piston engines has reportedly been developed by Chrysler Corp. The company said that in a recent 1,200-mile economy test, a 1959 Plymouth with the turbine engine averaged 17-20 miles per gallon. This compares with 13-14 obtained by a test Plymouth turbine in a cross-country run two years ago.

Chrysler said before the engines can be mass produced the company must determine (1) How much piston engines will be improved in coming years, and (2) Will turbines be more expensive to build than reciprocating engines, assuming production methods could be developed?

U. S. Octane Ratings Reach New High, Survey Shows

Octane ratings of gasoline throughout the United States have reached new highs, the Bureau of Mines has revealed.

The report is based on a nationwide survey conducted on gasoline ratings during the summer, 1958, the latest period for which complete statistics are available.

Analyses of 6,157 samples collected from gasoline pumps showed that the average regular-price gasoline sold last summer had a research octane rating of

WITH

TAYLOR-WHARTON

The flexibility of MOBILIZED GAS STORAGE can now be yours with low-cost Taylor-Wharton Gas Transports. With these mobile storage units, you can eliminate the expense of charging remote permanent storage systems and greatly reduce initial cost and maintenance.

The heart of the Transport is a group of Taylor-Wharton seamless steel pressure vessels. Their quality, established by closely controlled manufacturing processes and rigorous inspection, makes the Taylor-Wharton Transport a sound investment in durable, up-to-date equipment. All vessels are normalized for extra safety and manufactured to I. C. C. 3A2400 specifications. Available in capacities of 38,500 to 56,000 cubic feet, the vessel groups are rigidly mounted on modern single or tandem-axle trailers. A weatherproof rear housing protects the valve and manifold system.

Catalog No. 58 gives complete details on this practical system for flexible gas storage. Write for it today.

More than a Century in Harrisburg 2, Pa.

H HARRISBURG STEEL CO.

Division of HARSCO CORPORATION

CYLINDERS TUBES FLANGES COUPLINGS

For more data on advertised products, use Readers' Service Cards, last page.

A-W Hydraulic Crane speeds heavy valve assembly to maintenance shop at Sun Oil's Toledo refinery.

Austin-Western Hydraulic Crane proves safe, fast, economical in 3 years' operation at Sun Oil refinery

"Safety was one of the main reasons we purchased an Austin-Western Hydraulic Crane 3 years ago for refinery maintenance. The positive hydraulic control of boom and hoist on this self-propelled precision crane protects personnel and prevents accidents that result from makeshift methods of lifting and moving," we are told by Sun Oil's Toledo refinery.

Dispatcher Records Provide Proof

"Operating time and use are recorded by a vehicle dispatcher. His records provide positive proof that the A-W is safer, easier, faster, more mobile, and less costly than large cranes. It costs less per shift than half of one man's wages.

"We discover new uses daily for it. It goes where big cranes can't. With a ½-yd. bucket attachment, it is even used to pour concrete. It helps maintain our truck fleet, too. It handles engines and tires and, with all-wheel drive, it doubles as a wrecker and towing vehicle.

Does Difficult, Dangerous Jobs Better

"Not only does the A-W do so many difficult jobs better, but it does them more safely and easily. For instance, crane and operator can safely remove heavy gas compressor pistons and transport them to the maintenance shop in 1 hour. This saves 2½ man-hours plus 2 hours' time for truck and driver.

"Our big 10-ton crane couldn't reach a 1000-lb., 6-ft.-long crude oil pump element. But the A-W, with all-wheel steering, maneuvered right up to the pump, removed the element, and delivered it ¼ mile away in less than an hour.

"The A-W is so useful we hired a night operator. The crane pays for his wages with the time it saves by preparing jobs for the next day.

Works 500 Shift-Days per Year

"Our A-W averages two shifts daily—a total of 500 shift-days a year. Often it works a third shift for overtime work or to shorten downtime on equipment. It's easy to operate. A number of our maintenance men can put it through its paces.

"This inexpensive hydraulic crane is another modern tool to help our men do their work more safely, more efficiently, and at lower cost!"

Send for the complete Sun Oil Toledo refinery story—Gould Certified Report No. 5712. Write today.

Austin 100th YEAR Western

CONSTRUCTION EQUIPMENT DIVISION, AURORA, ILL.

BALDWIN · LIMA · HAMILTON

Power graders • Motor sweepers • Road rollers • Hydraulic cranes

What's Happening . . .

90.2, up .4 of a point from the summer of 1957. Premium-price gasoline averaged 98.4, up .8 of a point. Super-grade gasolines averaged 101.4, up .5 of a point.

The greatest spread was in the regular-price grades. Lowest rating reported was 83, highest, 95. The lowest rating for premium-price gasolines was 92.2 and the highest, 101.3. This marked the first time in the history of the survey that a premium-price gasoline reached or passed the 100-octane level. In the super-grade gasolines, the lowest octane rating found was 99.8 and the highest was 102.5. The latter was the highest ever recorded.

In the latest study, the Bureau notes that the super-grade gasolines are becoming customary products and are available from an increasing number of service stations.

By way of contrast, the octane rating of regular price gasolines sold in the summer of 1948 averaged 80.1, compared with 1958's 90.2. Premium-price fuels in 1948 had average octane ratings of 86.1, compared with today's 98.4. No super-grade gasolines were being sold at gasoline filling stations a decade ago.

Dittmer Is Named Head Of Petroleum Research Fund

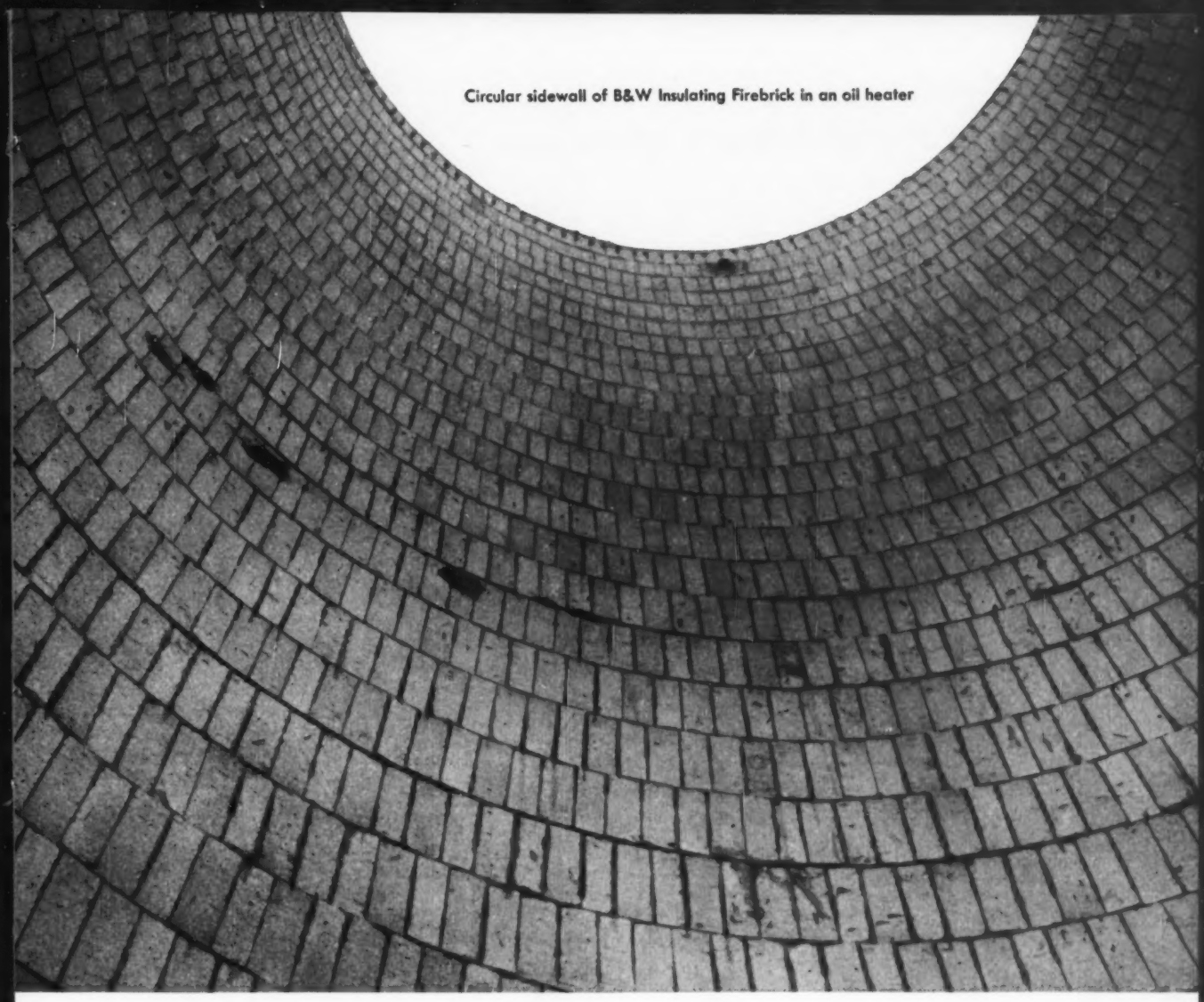
Professor Karl Dittmer, former head of the Florida State University Department of Chemistry and an outstanding scientist and chemical educator, has been named program administrator of the Petroleum Research Fund, administered by ACS. His office will be in the Society's national headquarters, Washington.

Dr. Cary R. Wagner of Utica, Ohio, petroleum consultant, continues as chairman of the Petroleum Research Fund Advisory Board, appointed by the ACS board of directors to solicit proposals and make recommendations on specific allocation of funds.

The fund, which has spent $2 million for grants since 1954, sponsors fundamental investigations in the petroleum field which may lead to developments in such areas as air pollution, formulation of new plastics, methods of improving gasoline, and synthesis of petroleum derivatives of potential importance to the industry.

Free World Demand Rise For '59 Forecast at 7.5%

An oil demand increase for the Free World of about 7.5 percent, and nearly 5 percent in domestic demand has been forecast by R. G. Follis, chairman, Standard Oil Co. of Calif. He said "oil inventories will be in much better balance, notwithstanding a continuation of a fuel oil surplus on the West Coast." "All evidence points to a strengthening in domestic production in 1959 which should recover any volume losses of 1958," he added. He



Circular sidewall of B&W Insulating Firebrick in an oil heater

How B&W Insulating Firebrick cut processing costs

Here are four *key* reasons why B&W Insulating Firebrick reduce over-all costs in chemical and petroleum process furnaces:

High Hot Load Strength —B&W IFB provide maximum load-bearing capacity *under operating temperatures.* Many oil heaters have been built with walls 80 feet high *with no intermediate support.*

Low Heat Storage — Cost-cutting B&W IFB have the *lowest* heat storage of any insulating firebrick. Since B&W IFB cool off fast, they protect expensive alloy tubes in the event of forced shut-down . . . make possible quick access to the furnace for inspection. They also reach operating temperature quickly, reducing cycle time and fuel bills.

Long Life — B&W Insulating Firebrick are *long* lasting because of the exceptional refractory nature of their base ingredients and the high processing temperatures to which they are subjected during manufacturing.

Short Installation Time —You save materially with B&W Insulating Firebrick because they are machined to size. They may be modified to fit door openings, peepholes, and other special conditions because they can be cut, drilled or shaped on the job with ordinary woodworking tools.

These sound reasons explain why process furnace builders and operators specify B&W Insulating Firebrick. Learn how these lightweight brick can help you save money. Your B&W representative will be glad to give you facts and figures.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W REFRACTORIES PRODUCTS:
B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide • B&W Ramming Mixes • B&W Kaowool

R-615

Your *FISHER/MAN* offers you

SPEEDY DELIVERY

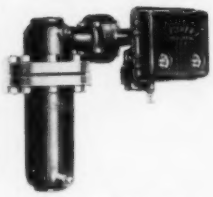
From the Factory Stocked

FISHER SUPERMARKET

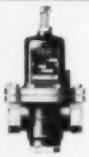
Where you can shop by phone, wire or TWX

Type 657-A with 3500 positioner

Type 4150 and 4160 Wizard II Pressure Controllers



Series 2500-249 and 2500-259B Level-Trols

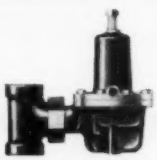


Type 95-H Pressure Reducing Valve

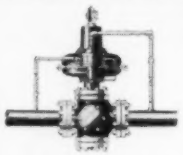
Type 630 "Big Joe" Field Regulator

Series 99 Multi-Purpose Gas Regulators

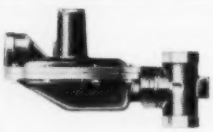
Type 655-A Pressure Regulator



Series 620 and 621 Farm Tap Regulators

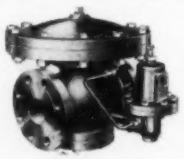


Series 298T Gas Regulators



Series S100 and 730 Service Regulators

Series 67FR Combination Filter-Regulator



Type 92B Pilot Operated Steam Reducing Valve

This "supermarket" availability of Fisher Control Valves and Controllers makes your delivery problems a thing of the past. Fisher keeps a stock of the equipment at left always on hand ready to ship to you at hourly notice. This means emergency requirements are met without costly delivery delays. This stock of control equipment includes all the most popular types in standard sizes.

In addition to the large factory stock, the Fisher offices in the column to the right which are starred carry a big selection of Fisher equipment in inventory to assist you.

Fisher constantly reviews the stock carried in the Supermarket and adds new items from time to time when your needs indicate.

Phone, wire or TWX (Marshalltown 578 or 579) and Fisher will have your order en route in a matter of hours, Saturday and Sunday excepted.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

FISHER® Controls

SINCE 1880

Now, for emergency needs contact FISHER or the representatives listed below.

*AMARILLO
Vinson Supply Company
*ATLANTA
J. M. Smither & Company
BALTIMORE
The Rhodes Controls Company
BIRMINGHAM
Joseph W. Eshelman & Company
BOSTON
Clarence B. Petty & Company
BUFFALO
W. J. Sommers Company
*CALGARY-EDMONTON
Barber Engineering & Supply Company
CARACAS, VENEZUELA
Sinclair Spence
*CHARLOTTE
Robert E. Mason & Company
CHICAGO
General Meters & Controls Company
CINCINNATI
H. T. Porter Company
*CLEVELAND
A. E. Ehrke & Company
*DALLAS
Vinson Supply Company
*DENVER
Joy & Cox, Inc.
*DETROIT
DuBois-Webb Company
*HOUSTON-CORPUS CHRISTI
Puffer-Sweiven Company
INDIANAPOLIS
Acme Engineering Agency
KANSAS CITY
Sullivan-Mears Company
*LOS ANGELES
B. R. Jones & Company
LOUISVILLE
Allan K. Cook Company
MARSHALLTOWN
R. S. Stover Company
MEMPHIS–NASHVILLE
Johnson & Scott
MEXICO, D. F.
Babcock & Wilcox de Mexico
MILWAUKEE
W. D. Ehrke & Company
MINNEAPOLIS
R. G. Read & Company
MONTREAL
Process & Steam Specialties, Inc.
*NEW ORLEANS–LAFAYETTE
John H. Carter Company
NEW YORK
Crabbe & Stebbins Company
*ODESSA–FARMINGTON
Vinson Supply Company
PHILADELPHIA
Clifford B. Ives & Company
PHOENIX
Cone & Wallace Company
PITTSBURGH
J. G. Chilcoat & Company
PORTLAND
R. H. Brown & Company
RICHMOND
W. H. Kidd Company
*ST. LOUIS
H. D. Hale & Company
SALT LAKE CITY
Williams, Gritton & Wilde
*SAN FRANCISCO
George R. Friederich & Company
*SEATTLE
Power & Controls, Inc.
*SHREVEPORT
John H. Carter Company
TORONTO
George W. Beecroft & Company
*TULSA
Vinson Supply Company
VANCOUVER
Northern Columbia Process Equipment Company
*WICHITA–LIBERAL
Sullivan-Mears Company
WINNIPEG
Mechanical Valve & Engineering Spec.

predicted a 430,000-bpd rise in domestic demand in 1959 and continued growth of petrochemicals, which account for almost 60 percent of all U.S. chemical sales.

Last Quarter Domestic Oil Use Increased, Says IPAA

An increase of about 500,000 bpd in U.S. petroleum product consumption during the fourth quarter of 1958, as compared to the same period a year ago, has been reported by the IPAA.

In its monthly supply and demand outlook, the association said domestic consumption during the last three months increased 566,000 bpd or 6.2 percent and averaged 9.72-million bpd. Because export demand declined 66,000 bpd during the period, total domestic and export demand averaged about 10-million bpd, an increase of about 500,000 bpd, or 5.3 per cent beyond levels of a year ago.

NPC Alters By-Laws to Add Government Member

The National Petroleum Council has changed its by-laws to conform to the Justice Department's rules for advisory groups. The Council approved, by a 66-1 vote, a new government co-chairman for the group, and agreed to keep written minutes of all meetings and discussions. Capt. Matthew V. Carson, Jr., Federal oil administrator, will be the government representative.

J. Howard Marshall, vice president of Signal Oil & Gas Co., and a member of the rules-changing committee, said the amendments "don't do much more than formalize what we had previously been doing."

Recent 5% Wage Increases Gaining Wide Acceptance

Recent five percent wage increases by most major oil companies were being accepted by OCAW locals, and the offer's momentum was gaining throughout the nation by the end of January. In most companies the five percent increase was offered to both non-union and union personnel.

While the plan has been generally accepted in most areas, there has been some criticism. J. Elroe Brown, District 4 director of OCAW at Houston said that "strings attached to the offer have made for a confused bargaining picture on the Gulf Coast." Reasons he gave:

- Gulf was seeking a closed contract.
- Sinclair was putting off bargaining on pensions.
- Shell was demanding that all issues be settled before the five percent is granted.
- American Oil was seeking an amended contract with a one-year freeze on wages.

What's Happening. . .

–Changing Times–

"Largest closed circuit telecast ever held in oil industry" has been staged by Phillips Petroleum Co. from Bartlesville to company's wholesale and retail distributors meeting in **37 cities from coast to coast.**

Details of proposed **sale of Universal Oil Products Co. stock have been disclosed** by Securities & Exchange Commission. Stock's price was not revealed, but **2.9 million shares are involved.**

Bill for fast **tax writeoffs for cost of smog-treatment works has been reintroduced** to House by Representative Lipscomb (R-Calif.). He also offered bill to extend Air Pollution Control Act.

Donations totaling **$1.2 million will be awarded in 1959 by Shell Companies Foundation, Inc.,** to educational, charitable, religious and public service organizations.

Colorado Oil & Gas Corp. has acquired Jas. P. Marsh Corp. and subsidiaries. Marsh will retain identity, personnel, sales representation and policies, with some changes in board-executive officers.

National Conference on Air Pollution has predicted **a 1959 expenditure of $250 million on air pollution prevention** by nation's chemical companies alone.

Marine activities of the Butterworth System, Inc., an affiliate of Standard Oil Co. (N. J.) **have been transferred** to Esso Standard Oil Co.'s Marine department.

Royal Oil Co., ordered by Federal Trade Commission to **label lubricating oil to show that it is derived from used rather than virgin oil,** says it won't appeal Circuit Court of Appeals ruling that upheld FTC order.

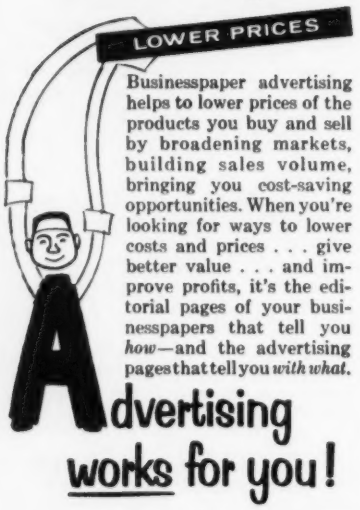
Commerce Oil Refining Co. will appeal to Circuit Court of Appeals, Boston, **as next step in attempt to build refinery on Jamestown, R. I.** Lower court overruled Jamestown Town Council's approval of project.

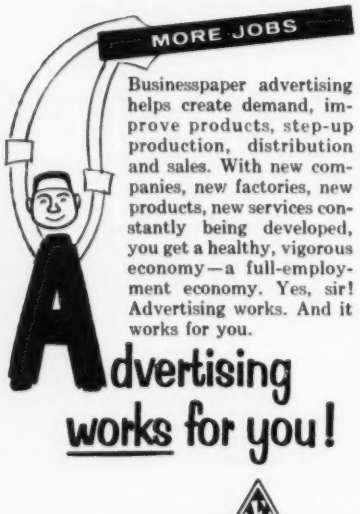
Eisenhower budget has called for **federal gasoline tax boost from 3 cents per gallon to 4.5 cents.** Aviation gas would go from 2 cents per gallon to 4.5 cents. **A new tax covering jet fuels would be 4.5 cents per gallon.**

World tonnage of oil tankers rose 8.2 percent in 1958, or by 3.6 million tons to 33.6 million tons. **At end of year, there were 4,023 tankers of 100 tons and over** in world, which accounted for 28.5 percent of world shipping.

For more data on advertised products, use Readers' Service Cards, last page.

BETTER PRODUCTS
Businesspaper advertising brings you information on new and better products, alerts you to new processes and production methods by which you can improve your own products. That's why it pays to read the advertising in your businesspaper. Helps you keep an ear to the ground for new and important developments you can put to work —profitably.
Advertising works for you!


LOWER PRICES
Businesspaper advertising helps to lower prices of the products you buy and sell by broadening markets, building sales volume, bringing you cost-saving opportunities. When you're looking for ways to lower costs and prices . . . give better value . . . and improve profits, it's the editorial pages of your businesspapers that tell you *how*—and the advertising pages that tell you *with what*.
Advertising works for you!


MORE JOBS
Businesspaper advertising helps create demand, improve products, step-up production, distribution and sales. With new companies, new factories, new products, new services constantly being developed, you get a healthy, vigorous economy—a full-employment economy. Yes, sir! Advertising works. And it works for you.
Advertising works for you!

Advertising Federation of America
Advertising Association of the West

Prepared for AFA and AAW by the Associated Business Publications in the interest of better understanding of businesspaper advertising.

MEETINGS CALENDAR

FEB. 1959	
23–25	American Society of Mechanical Engineers, Symposium on Thermal Properties of Gases, Liquids and Solids, Purdue University.
26–27	American Petroleum Institute, Division of Marketing, Lubrication Committee Meeting, Sheraton-Cadillac Hotel, Detroit.
27	Natural Gasoline Association of America, Permian Basin Regional Meeting, Schorbaur Hotel, Midland, Texas.
MAR.	
4– 5	University of Oklahoma Gas Processing Conference, Norman, Okla.
6–	Natural Gasoline Association of America, Gulf Coast Regional Meeting, Robert Driscoll Hotel, Corpus Christi.
8–12	American Society of Mechanical Engineers, Gas Turbine Power Conference and Exhibit, Netherlands-Hilton Hotel, Cincinnati.
9–11	Midwest Gas Association, Annual Meeting, Hotel Fort Des Moines, Des Moines.
13	American Institute of Chemical Engineers and American Chemical Society, 6th Annual Joint Technical Meeting, Beaumont, Texas.
16–18	Western Petroleum Refiners Association, Annual Meeting, Hilton Hotel, San Antonio.
16–20	National Association of Corrosion Engineers, Corrosion Show and Annual Conference, Sherman Hotel, Chicago.
16–20	American Society for Metals, et al, Western Metal Exposition and Congress. Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles.
16–20	American Institute of Chemical Engineers Meeting, Chalfonte Hotel, Atlantic City
31	American Institute of Chemical Engineers, Experience in Industry Symposium, Museum, University of Pennsylvania.
APRIL	
5–10	Nuclear Congress, Cleveland Auditorium, Cleveland.
5–10	American Society of Mechanical Engineers, Nuclear Congress, Cleveland Auditorium, Cleveland.
5–10	American Chemical Society, 135th National Meeting, Boston.
6– 7	Instrument Society of America, 2nd Annual Symposium on Chemical & Petroleum Instrumentation, St. Louis.
13–17	Annual Safety Convention & Exposition, Hotel Statler, New York.
14–16	Southwestern Gas Measurement Short Course, Drill Hall, North Campus, University of Oklahoma.
15–17	National Petroleum Association, Semi-annual Meeting, Hotel Cleveland, Cleveland.
19–23	American Society of Mechanical Engineers, Oil and Gas Power Conference and Exhibit, Shamrock Hilton Hotel, Houston.
21–23	American Society of Lubrication Engineers, Annual Meeting and Exhibit, Hotel Statler, Buffalo, N.Y.
22–24	Natural Gasoline Association of America, Annual Convention, Baker and Adolphus Hotels, Dallas.
23–24	American Society of Mechanical Engineers and Society of Apparatus Manufacturers, Management Conference, Statler-Hilton Hotel New York.
29–30	Western Petroleum Refiners Association, Southwest Regional Technical-Industrial Relations Meeting, Hotel Paso del Norte, El Paso.
MAY	
3– 6	Liquefied Petroleum Gas Association, Annual Meeting, Conrad Hilton Hotel, Chicago.
4– 5	American Society of Mechanical Engineers, Maintenance and Plant Engineering Division Conference, Edgewater Beach Hotel, Chicago.
4– 8	American Petroleum Institute, Safety and Fire Protection Committees, 12th Midyear Meeting, Rice Hotel, Houston.
MAY	
5– 7	Annual Industrial Waste Conference, Purdue Memorial Union Building, Lafayette, Ind.
11–13	American Institute of Electrical Engineers, Conference on Automatic Techniques, Chicago.
14–16	American Institute of Industrial Engineers, National Industrial Engineering Conference and Convention, Biltmore Hotel, Atlanta.
14–23	International Petroleum Exposition, Tulsa.
18–20	Instrument Society of America, 5th Annual Symposium on Instrumental Methods of Analysis, Shamrock Hilton Hotel, Houston.
25–27	American Society of Quality Control, Industry Production and Quality Control Exposition, Cleveland.
25–28	American Society of Mechanical Engineers, Design Engineering Conference, Convention Hall, Hall, Philadelphia.
27–29	Annual Short Course in Gas Technology, Texas College of Arts and Industries, Kingsville, Texas.
27–30	American Petroleum Institute, Division of Refining, Midyear Meeting, New York.
JUNE	
1– 5	Fifth World Petroleum Congress Exposition, New York Coliseum, New York.
10–12	Instrument Society of America, International Symposium on Gas Chromatography, East Lansing, Mich.
14–19	Society of Automotive Engineers, Summer Meeting, Chalfonte-Haddon Hotel, Atlantic City.
17–18	American Society of Mechanical Engineers, Engineering Management Conference, Statler Hilton Hotel, Los Angeles.
21–26	American Society for Testing Materials, Annual Meeting, Chalfonte-Haddon Hall, Atlantic City.
24–25	Western Petroleum Refiner's Association, Mid-Continent Technical-Industrial Relations Meeting, Broadview Hotel, Wichita.
AUG.	
10–13	Society of Automotive Engineers, National West Coast Meeting, Hotel Georgia, Vancouver, B.C.
SEPT.	
9–10	American Society of Mechanical Engineers, International Congress on Air Pollution, New York.
13–18	American Chemical Society, 136th National Meeting, Atlantic City.
17	Natural Gasoline Association of America, Rocky Mountain Regional Meeting, Casper or Calgary, Alberta.
20–23	American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference, Rice Hotel, Houston.
21–23	American Society of Mechanical Engineers, Petroleum Conference, Rice Hotel, Houston.
21–25	Instrument Society of America, Annual Instrumentation-Automation Conference and Exhibit, International Amphitheater, Chicago.
23–24	Western Petroleum Refiner's Association, Rocky Mountain Technical-Industrial Relations Meeting, Henning Hotel, Casper.
OCT.	
7– 8	Western Petroleum Refiners Association, Annual Stream Pollution and Waste Disposal Conference, Broadview Hotel, Wichita.
16	Natural Gasoline Association of America, Southern Regional Meeting, Carlton Hotel, Tyler, Texas.
28–29	Western Petroleum Refiners Association, Question and Answer Session on Refining Technology, Rufus Garrett Hotel, El Dorado, Ark.

COOPER ALLOY VALVE BRIEFS

THE VALVE AND FITTINGS ANSWER CORNER

Carl Tylka, Cooper Alloy Technical Service Director, answers your questions on stainless valves and fittings.

Q. *How can one remedy a hydraulic hammer produced in a piping system during closing of a motor-operated gate valve?*

A. Hydraulic hammer indicates an excessive pressure buildup rate caused by too rapid a valve closing cycle. Lengthening the time of closure will eliminate this condition.

Q. *What to do about interruption of closure of motor-operated gate valve caused by the torque switch cutting out when in the near-closed position?*

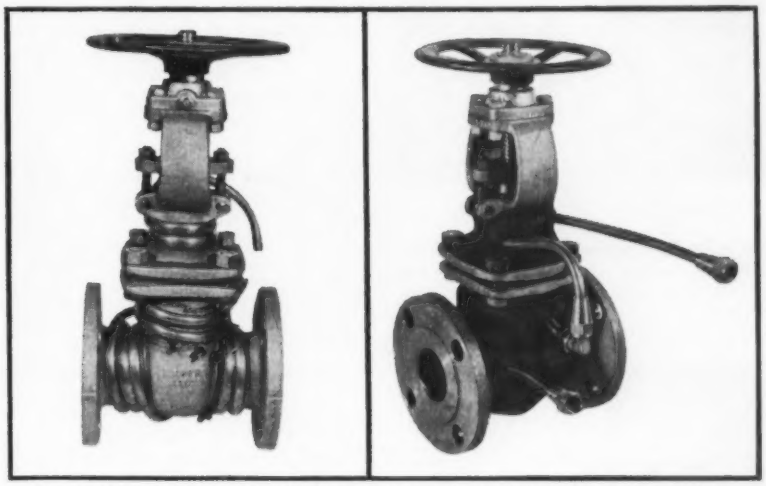
A. Increase the spring load in the operator torque cutout. Obviously, the disc when approaching the closed position develops across it larger pressure drops and resulting friction, which requires operating power in excess of the maximum passable through the torque cutout.

Q. *Does V2B stainless alloy lend itself to use in valve discs?*

A. Yes. V2B's corrosion and erosion resistance, plus its non-galling characteristics, are ideally suited for valve disc applications. Typical Brinell hardness values range from 302, as cast, to 363 when annealed and hardened. V2B contains Mo, Si, Cu, and Be, and is easily machined in the quench-annealed condition (Brinell 269). Corrosion resistance to H_2SO_4, HCl, H_3PO_4, and their salts in the hardened condition exceeds that of all other precipitation-hardenable alloys, and even 316-type stainless. Its resistance to highly concentrated hot HNO_3, however, is less than that of 304 and 316.

Q. *In open-shut operations, which type gate valve is preferable: wedge type, or parallel-faced disc type?*

A. This depends on many variables such as system pressure, temperature, and differential pressure across the disc. With low system pressures and temperatures, the wedge type is preferred for positive shutoff. With high temperature-pressure systems, however, since shutoff tightness is directly affected by pressure drop across the disc, the parallel-faced disc type is preferable, especially in regard to required stem torque and disc binding.



Thermon fills voids between body and tubing, providing continuous heat-flow path between heating element and valve body. It can be easily removed for repair of leakage in tracers

We've Cut Jacketed Valve Cost By 75%

Standard Cooper Alloy stainless steel valve models with low-cost Thermon* jacket are designed for use in hot or cold service

Thermon, a non-metallic plastic compound with highly efficient heat-transfer properties when factory-applied to standard Cooper Alloy stainless steel valves with conventional steam traced or thermal electric systems, permits all the performance advantages and none of the problems generally associated with jacketed units. You can even use standard piping without juggling sizes, and product contamination, usually a big problem with most jacketed units, is not possible, because we have eliminated the need for complicated castings which are subject to hidden defects.

What's more, the costs are one-quarter of what you would expect to pay for jacketed valves. Thoroughly tested under all operating conditions, Cooper Alloy Thermonized valves have the high performance characteristics equal to the most efficient jacketed units, in operating temperature ranges from below zero up to 750°F.

Cooper Alloy Thermonized valves make maintenance problems easy. Should tracer leaks develop, they can be quickly found and repaired. With a minimum of down time required, your processing operation can be continued without a great loss of productive hours and manpower.

With Cooper Alloy Thermonized valves you get all the high quality features you expect in a Cooper Alloy product. You get high-performance, lower-cost jacketed valves, and you can get practically off-the-shelf delivery to meet your production needs. For further details, request engineering data folder from Cooper Alloy Corp., Hillside, N. J.

*Thermon is a product of the Thermon Mfg. Co., Houston, Texas.

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening . . .

. . . *Among Men* in the Industry

Dantzler

Carlson

Eugene C. Carlson has been appointed technical superintendent for the new polyethylene plant of U. S. Industrial Chemicals Co., which will be completed early in 1959 at Houston. Carlson has a B.S. degree in chemical engineering from the University of Arkansas, and attended the University of Wisconsin. Prior to his new appointment, he was in the Chemical Development department of the company's New York office.

Richards

T. Howard Dantzler has been appointed superintendent of operations at the plant. He has a B.S. degree in chemical engineering from Mississippi State College. He was formerly an assistant area superintendent at the company's Tuscola, Ill., plant.

E. P. Richards has been made chief engineer for the Houston plant. He received a B.S. degree in mechanical engineering from Texas A. & M. College, and he was with Ethyl Corp. from 1947-48 and Copolymer Corp. from 1948-53. Prior to his new assignment, Richards was at the company's Tuscola, Ill., plant.

Alan C. Harrop has been elected a director of Imperial Oil, Ltd. Formerly manager of Imperial's Employe Relations department, he has had wide experience in oil refining operations in Canada and South America. Harrop received a B.S. degree in chemical engineering from the University of Toronto in 1925. Upon graduation he joined Imperial as an assistant chemist at the Calgary refinery. He has been head of the Employe Relations department since 1951.

C. H. Coughlin has been named a member of the board of directors, American Oil Co. He recently was named general manager of sales for American Oil.

Edwin C. Holmer of Esso Research and Engineering Co. has been named manager of the Production division, Jersey Production Research Co., Tulsa. He takes over the new assignment February 1. Currently an assistant director of Esso's Chemicals Research division, Linden Research laboratories, he joined the company in 1942 at the Bayway refinery.

R. T. Fisher has been named employe relations manager of Canadian Oil Companies, Ltd. He has been with the company since 1933 and was formerly personnel manager. Fisher will develop employe relations policies throughout the company, and will headquarter at Toronto.

Arthur L. Goeschel has been appointed plant manager of Dixon Chemical & Research, Inc.'s Paulsboro, N. J. plant. He was most recently plant manager at the Columbia National plant, Pensacola, Fla. Previously he was plant manager at the Stauffer Chemical plant in Niagara Falls, N. Y. Goeschel has a B.S. degree in chemical engineering from the City College of New York and a M.S. degree in administrative engineering from New York University.

Frank W. Bowen has been named assistant to the vice president in charge of manufacturing for Sun Oil Co. Starting with Sun as a chemical engineer at Marcus Hook, Pa., in 1939, Bowen has been chief chemical engineer at the Toledo, Ohio, refinery and superintendent of Sun Oil Co., Ltd.'s Sarnia, Ont., refinery. He was refinery engineer at Sun's Marcus Hook plant before his appointment.

Bowen

Myles J. Connor, Jr., has been appointed assistant director in the Planning Engineering division, Esso Research and Engineering Co., in charge of operations research activities. With the company ten years, he graduated from Columbia University with a M.S. degree in mechanical engineering. He previously attended Rutgers University.

W. D. Nelson of Gulf Oil Corp.'s Philadelphia division has become division general manager, New York division. **J. B. Kelley,** formerly division manager, retail and jobber sales of the Philadelphia division, has become division general manager, Philadelphia.

Thomas M. McQuilling has been named general manager of the Marine department, American Oil Co. Currently manager of the Marine department, Hess, Inc., he graduated from the U.S. Naval Academy in 1944.

John L. Lugli has been named a senior engineer in The Texas Co.'s Petrochemical department, New York. He previously was in the Process Engineering group at the company's Lockport, Ill., refinery. He graduated from Columbia University with a B.S. degree in chemical engineering in 1953 and joined Texaco that year at Lockport.

William Priestley, Jr., has been named an acting assistant director in Esso Research and Engineering Co.'s Process Research division. He has been with the company since 1939, having first received B.S. and M.S. degrees in chemical engineering from Lehigh University. He is the author of numerous papers on distillation and spectroscopy.

Glenn W. Poorman, Esso Standard Oil Co. vice president, has been elected a vice president, director and member of the executive committee, Esso Export Corp. He has been an Esso Standard vice president since 1956 and a director since 1954, having begun his Esso career in 1932.

General James H. Doolittle has retired as a vice president of Shell Oil Co. On January 1, he became board chairman of Space Technology Laboratories, Inglewood, Calif. Doolittle has been with Shell since 1930, when he left active duty with the Air Corps to become manager of the company's Aviation department. He has been a vice president and director since 1946.

John H. Easthagen has been named staff engineer for industrial pollution control, Standard Research Corp. A technical expert on air and water pollution, Easthagen will act as consultant to the management of California Research Corp. and Standard Oil Co. of Calif.

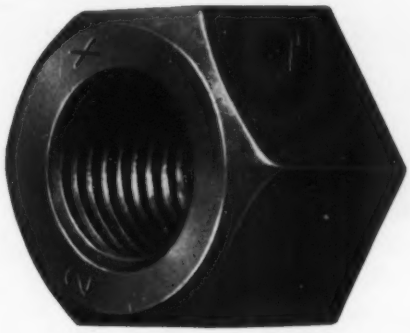
Easthagen

He is a member of the API committee on disposal of refinery wastes, the Western Oil and Gas Association's Waste Disposal committee and Bay Area Technical Subcommittee on Air Pollution Control. He is also on the Industrial Wastes committee, Califor-

ANOTHER IN A SERIES

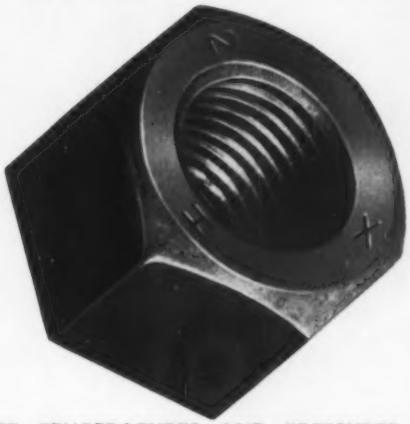
Unusual temperatures and pressures? You can count on these 4 nuts!

These four nuts are the best you can buy for your high or low temperature, or high pressure, applications. Each grade meets a specific operating condition. Each meets ASTM Specification A-194. Each is tapped to Class 2B fit. And each is available in the full size range.



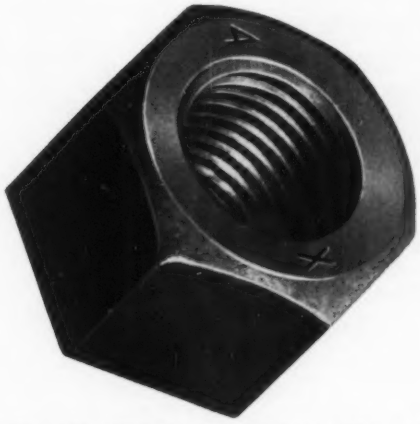
MODERATELY HIGH TEMPERATURES AND PRESSURES. Choose **GRADE 2,** a medium-carbon steel nut.

Carbon	Phosphorus	Sulphur	Brinell Hardness
0.40 min.	0.05 max	0.05 max	160 min



HIGHER TEMPERATURES AND PRESSURES. Choose **GRADE 2H,** a quenched and tempered medium-carbon steel nut.

Carbon	Phosphorus	Sulphur	Brinell Hardness
0.40 min.	0.05 max	0.05 max	248 to 352



SEVERE TEMPERATURES AND PRESSURES. Choose **GRADE 4,** a quenched and tempered molybdenum steel nut.

LOW TEMPERATURES. Choose **GRADE 4L,** a quenched and tempered molybdenum steel nut, which meets requirements of ASTM Specification A-320. Minimum Charpy impact value of 15 ft-lb down to —150F.

Carbon	Manganese	Phosphorus	Sulphur	Silicon	Molybdenum	Brinell Hardness
0.40 to 0.50	0.50 to 0.95	0.04 max	0.05 max	0.15 min	0.20 min	248 to 352

Whatever you need in nuts, studs, bolts or other fasteners, we can furnish it. Bethlehem makes a full range of standard and special fasteners to meet all refinery needs.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

For more data on advertised products, use Readers' Service Cards, last page.

ANOTHER IN A SERIES
OF MOTOR FACTS
FROM ALL INDUSTRIES

Westinghouse motors double normal life for this application

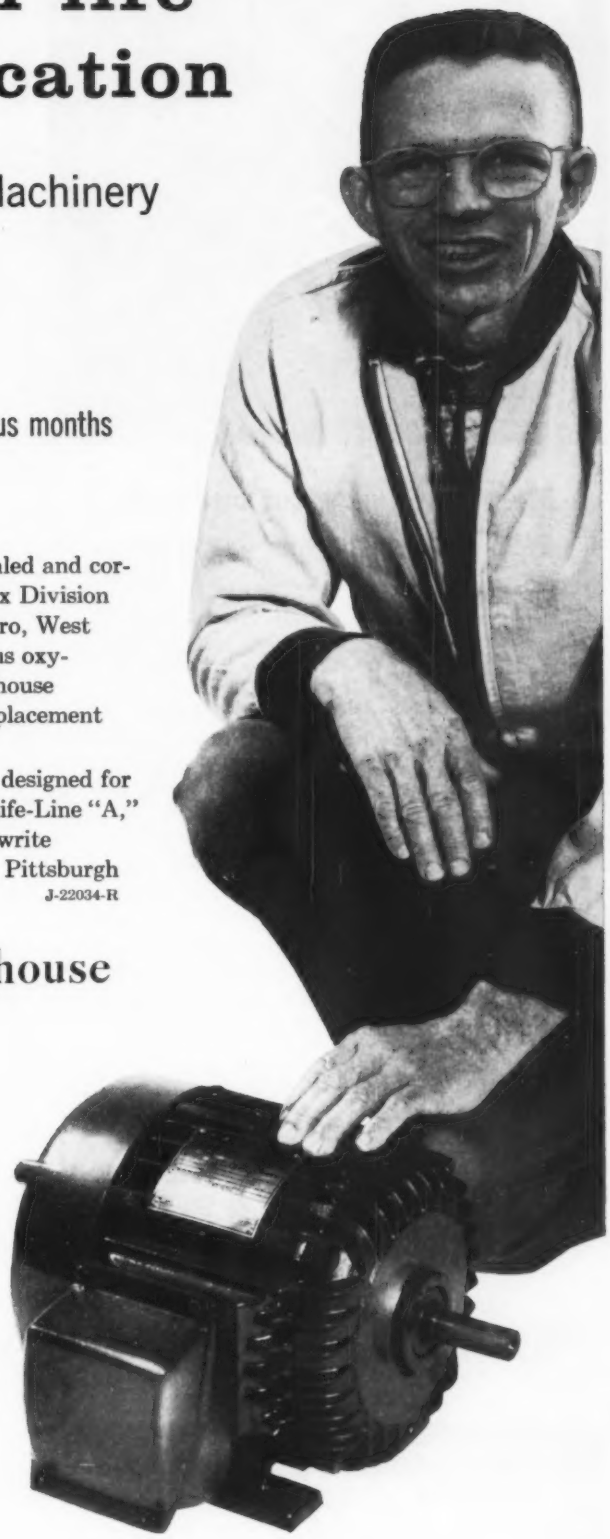
. . . at Ohio-Apex Div., Food Machinery and Chemical Corp.

this standard Life-Line A motor
still pumping corrosive POC I_3 after 12 continuous months
without maintenance or down time

"We must have a dependable motor, completely sealed and corrosion-resistant," says Mr. Burton Fitch, Ohio-Apex Division of Food Machinery and Chemical Corporation, Nitro, West Virginia. "A corrosive atmosphere, plus phosphorous oxychloride drip and seepage, cuts motor life. Westinghouse Life-Line® "A" motors have already passed this replacement point twice . . . and are still going strong."

Westinghouse motors last longer because they're designed for modern industry's needs. For more facts about the Life-Line "A," call your local Westinghouse representative . . . or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-22034-R

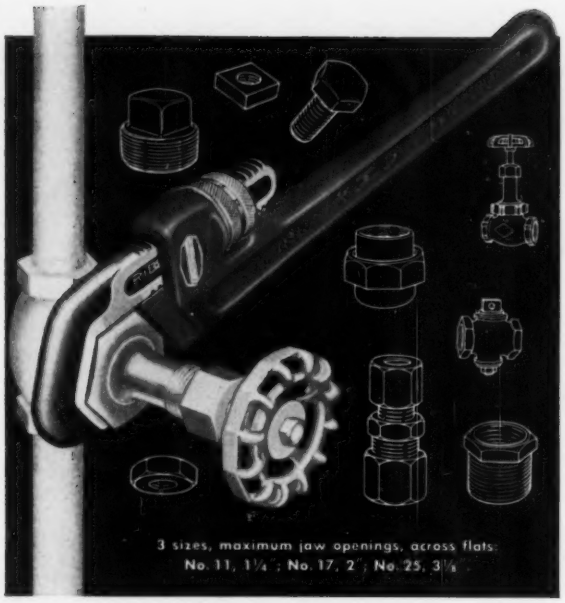
YOU CAN BE SURE... IF IT'S Westinghouse



←

Unretouched photo of Life-Line "A" three-hp motor driving chemical pump at 1730 rpm, 100 gpm at Ohio-Apex.

"Westinghouse Life-Line "A" motors have cut our motor costs substantially . . . helped us keep our chemicals moving down the line," says Mr. Fitch of Ohio-Apex. "Their built-in ruggedness, plus foolproof sealing against corrosion, means longer life, lower maintenance."



Master of Every Nut and Bolt...

NEW RIDGID®

Hex Wrench

Wide-open fast-action multi-sided grip on every hex, square and flathead!

Quick adjustment—stays to size . . . this new Hex Wrench goes on easily, won't slip off—harder you pull, the tighter it grips . . . no more skinned knuckles or rounded nut shoulders! Narrow jaw for close quarters. Famous RIDGID heavy-duty design, guaranteed housing, comfort-grip handle. Three sizes for ⅜" to 2" nuts. Make your work easier and faster—buy new RIDGID Hex Wrenches at your Supply House!

"Got the RIDGID name on it?... OKAY, I'll take it!"

The Ridge Tool Company Elyria, Ohio, U.S.A.

THREADED PIPE... It's Tight... It's Best... Costs Less!

PROCESS PLANT MAKER OF TOMORROW.....

Your plant engineering, fabrication and Construction probrems in Chemical, Petroleum, Petrochemical and nuclear fields ..... will be solved by CHIYODA's broad experiences in Engineering, Fabrication and Construction.

CHIYODA CHEMICAL ENGINEERING & CONSTRUCTION CO., LTD.

President: A. Tamaki

Tokyo Building, Marunouchi, Chiyoda-ku, TOKYO, JAPAN

Cable Address: "CHIYOTAKA TOKYO"

Men in the Industry...

nia Sewage and Industrial Waste Association.

Easthagen served on the Joint Federal, State, County and Industry committee on evaluation of emissions from refineries in Los Angeles County from 1955-58.

Bottomley

Malone

Marvin L. Bottomley has been promoted to chief estimator and **Charles B. Malone** to assistant chief estimator by The Refinery Engineering Co. A mechanical engineering graduate of Oklahoma State University, Bottomley was senior mechanical engineer at the Cushing, Okla., refinery of the old Deep Rock Oil Co., since bought out by Kerr-McGee Oil Industries, Inc. Previously, he held engineering jobs with Dow Chemical Co.; Jack & Hientz; Bureau of Ordnance, Navy Department; Cosden Petroleum Corp. and Shell Oil Co.

Malone, who has a B.S. degree in electrical engineering from Oklahoma State, joined Treco in 1956 as an estimator. He was formerly plant engineer for Coynco Products, Inc., Tulsa.

Robert L. Kerr, Jr., has been appointed superintendent of the Power department, The Atlantic Refining Co.'s Philadelphia refinery. He joined the Power department in 1929. Since 1956 he has been a departmental assistant.

H. R. Shepherd has been named assistant manager of Cities Service Oil Co.'s Industrial Relations division. He will supervise the labor relations phase of the division's activities. Shepherd joined Cities Service in 1947.

John H. Easthagen has been named staff engineer for industrial pollution control, California Research Corp. Easthagen will act as consultant to the management of California Research and Standard Oil Co. of Calif. He served on the joint Federal, State, County and Industry committee on evaluation of emissions from refineries in Los Angeles County, 1955-58.

Edward A. Pullen has been promoted to senior research chemist at Union Research center, Brea, Calif.

Dr. Burton C. Belden has been appointed assistant manager, office of scientific liaison, Esso Research and Engineering Co. He had been associate director of the firm's Process Research division for the last four years. Dr. Belden will survey scientific activities in industry, government, universities, research insti-

CORROSION RESISTANT
HEAT RESISTANT
Tube Supports

You can't buy Better Tube Supports... DURALOY Tube Supports are alloyed to meet individual corrosion and heat requirements. They are alloyed by experienced metallurgists and melted and cast by experienced high-alloy foundrymen, both groups with experience going back some thirty years. Castings are carefully tested in our own laboratories which are completely equipped for metallurgical, chemical and physical testing.

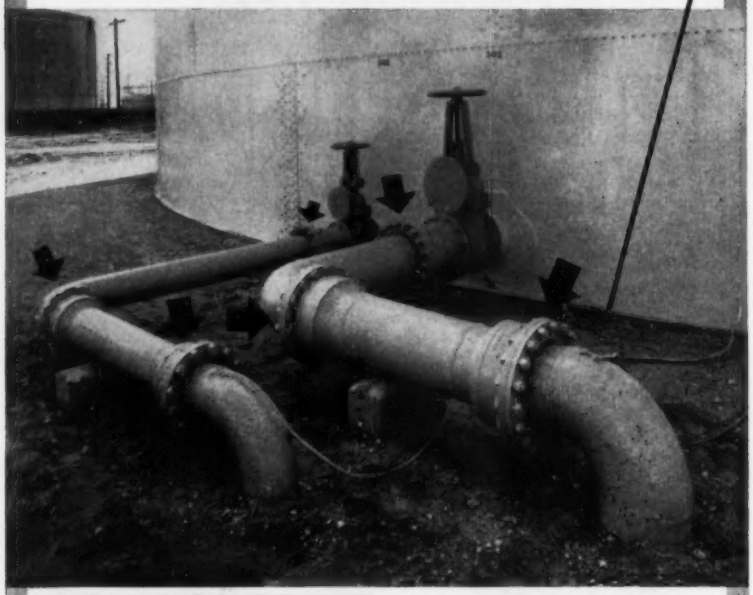
Many refineries have been DURALOY customers for years. Many refineries insist upon DURALOY castings. Whether it's straight production or engineering plus production, we are equipped to do the job. For more information, send for Bulletin No. 3150-G.

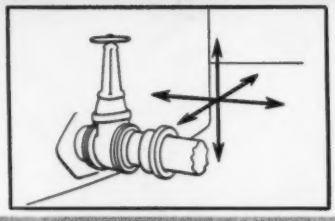
The DURALOY Company
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

For more data on advertised products, use Readers' Service Cards, last page.

Unlimited Flexibility!

—PROVEN IN SERVICE





Allows 6-Way Movement!

Freedom of movement in any direction is readily possible with these *ball joint connections* of 12" pipe (right) and 8" pipe (left) to 80,203 bbl. tank shown in above photo. (Photo: SHELL OIL COMPANY, Dominguez Refinery, Wilmington, Calif.)

Barco Ball Joints—

provide complete protection against FIRE, EARTH SHOCK, TANK SETTLING

The rapidly increasing use of Barco's new large size Flexible Ball Joints in California, and other locations, is significant for several key reasons:

1. **Fire-Safe. The joints have passed rigid fire and water spray tests.**
2. **Unlimited flexibility and movement.**
3. **Long service life without maintenance.**
4. **Joints insulate against electrolysis as well as provide movement in all planes.**

Such installations protect piping, valves, and tanks from earth movements, shifts, shocks, and earthquakes. They allow for *tank settling* or *tilting* as well as for *thermal expansion* or *contraction of piping* leading to tanks without creating strain. In case of fire, the joints are "fire safe."

For detailed information, WRITE FOR CATALOG 215B. Joints available in steel with flanged or welding ends. 15° angular flex.

PRODUCTS BACKED BY EXPERIENCE BARCO ANNIVERSARY 1900 50TH 1950

BARCO MANUFACTURING CO.

542C Hough Street • Barrington, Illinois

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints

In Canada: The Holden Co., Ltd., Montreal

Men in the Industry . . .

tutes and professional societies. He also will make recommendations for aid to research conducted outside the company and for other courses of action pertinent to the company's scientific interests. He has been with Esso Research since 1936.

Harold V. Bergstrand has joined the Whiting Research laboratories, Standard Oil Co. (Ind.) to do research on plastics obtained from petroleum products. He has a B.S. degree in chemical engineering from Illinois Institute of Technology, and is a member of the ACS and ASTM.

William A. Ackerman has been named a refinery engineer at Sun Oil Co.'s Marcus Hook, Pa. refinery. He received a B.S. degree in chemical engineering from the University of Illinois. Since 1955 he has been manager of the Technical Service division.

Dr. George Lukk has been named an engineering associate by Esso Research and Engineering Co. He joined the Planning Engineering division about a year ago. His current work deals with studies on the benefits of engineering research and with the planning of petrochemicals and fuels process projects.

Charles H. Barre' has been named vice president of refining for Republic Oil Refining Co., a division of Plymouth Oil Co. With the division for the last 13 years, he had previously been manager of the company's Texas City refinery.

Leonard Raymond, chief automotive engineer for research at Socony Mobil Oil Co., Inc., has been elected president of the Society of Automotive Engineers. In automotive research since obtaining a M.S. degree from Columbia University in 1928, he has been active in the Society for many years.

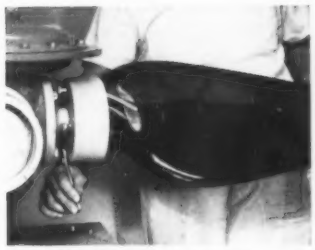
Sam H. Casey has been elected executive vice president of Commonwealth Oil Refining Co., Inc. With the organization since May, 1957, Casey will remain in charge of the New York office.

James C. Wishart has been appointed chief accountant for The Atlantic Refining Co.'s Crude Oil Accounting department, Dallas. He joined Atlantic from the New York office of The Texas Co. He was formerly controller of the Seaboard Oil Co. until its merger with The Texas Co. in 1958.

Fred P. Sewell, Delhi-Taylor Oil Corp.'s vice president of manufacturing and marketing, and his assistant, **Carroll C. Cook,** have moved into the company's main offices in Dallas. Headquarters had been at Delhi-Taylor's refinery in Corpus Christi.

Gardiner Blackman has been appointed manager of the Employee Relations department, Tidewater Oil Co. He previously was employe relations supervisor of the company's Western division.

Lightweight.



Easy installation and adjustment.

NEW HUDSON TUF-LITE FANS

After six years of development work and tests of trial field installations operating under wide ranges of conditions in cooling towers, finned tube coolers, and in highly corrosive chemical plant ventilating service, Hudson presents a new product—the TUF-LITE fan. The blades, cast in one seamless piece of fiber glass reinforced synthetic resin, are hollow, light and tough. TUF-LITE fans afford the following advantages over any other available type of fan:

SAFE: TUF-LITE blades being lightweight (about ¼ the weight of other blades with comparable capacity) and infrangible, eliminate the hazards to personnel and equipment existent through accidental throwing or disintegration of heavy metal, wood, or laminated blades while in service.

EFFICIENT: More air is moved at less horsepower because weight and finishing operations do not impose limitations on selections of best aerodynamic design; therefore nearly ideal airfoil cross sections, commercially attainable only in TUF-LITE blades, can be used. Blades will not sag or distort, and surfaces remain permanently smooth.

LOW MAINTENANCE: TUF-LITE blades are unaffected by corrosive, abrasive or impingement effects of hot saturated air, sand, rain, or hail, and have superior deterioration resistance to practically all corrosive vapors or liquids. Blade materials contain color pigment; no painting is necessary. Light weight reduces stress and maintenance on bearings, gears, drive shafts, and supports.

QUIET: The permanently smooth surfaces, very light weight, sustained perfect balance, and advanced aerodynamic design minimize noise.

EASE IN INSTALLATION: Light weight of blades and ingenious design of hub and blade coupling allows attachment of blades by one man using only small wrench. Coupling design assures uniformity of pitch of all blades, and as blades of same size are identical and interchangeable, perfect fan balance is preassured.

In replacement of present fans or in installations on new cooling equipment of any manufacture TAKE ADVANTAGE OF THE OUTSTANDING SUPERIORITY OF HUDSON TUF-LITE FANS.

Bulletin on TUF-LITE FANS
Available upon Request

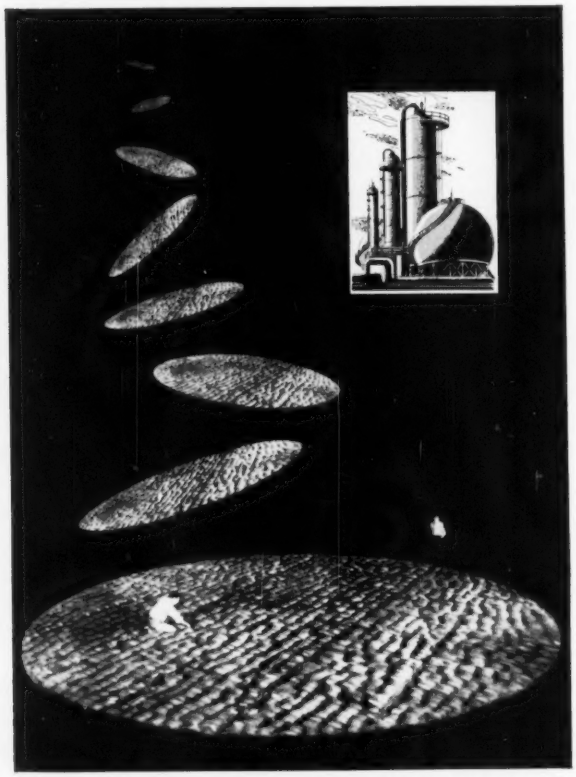
TUF-LITE protected by U.S. copyrights, patents and patents pending

HUDSON
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

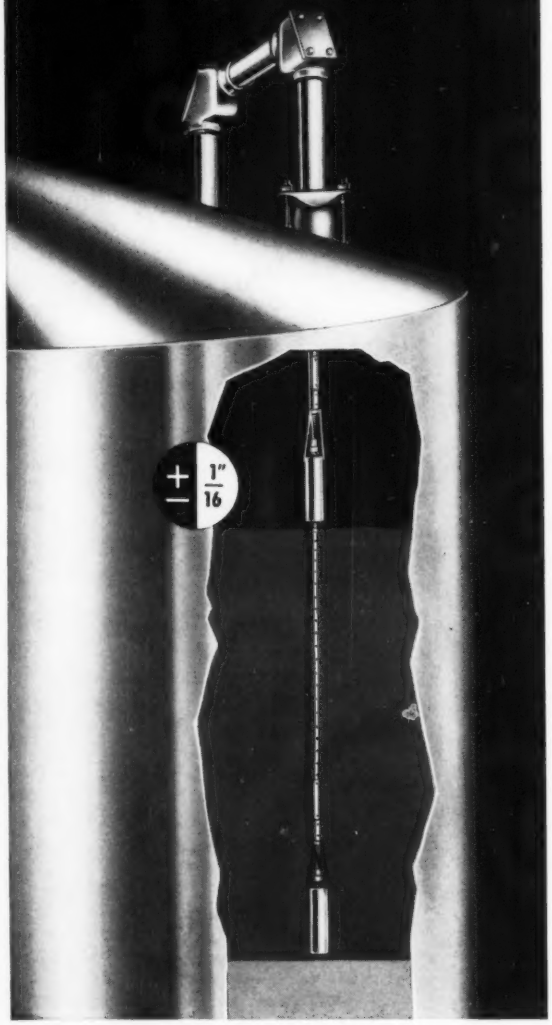
No liquid carry-over problem is ever too great for METEX!

In installation after installation...in all types of processing equipment—Metex mist eliminators are knocking back liquid entrainment...upping production...improving quality...cutting operating and maintenance costs. Your particular entrainment problem is no exception. For at Metal Textile we've been knitting low-cost answers to such problems since 1943. As the originators of knitted wire entrainment separators, Metal Textile has the engineering experience—and the research and production resources necessary to support that experience—to take on even the most difficult liquid entrainment problems. Our engineering department stands ready to help you solve your particular problems with complete design assistance. For latest design guides, write or call for Bulletin ME-9: Metal Textile Corporation, Roselle, N. J.



METAL TEXTILE CORPORATION
...world's largest and oldest producer of knitted wire products
A DIVISION OF GENERAL CABLE CORPORATION

NOW COMPLETE AUTOMATION IN TANK GAUGING!



You can eliminate hand gauging completely with the new Gilbarco electronic Tank Gauge because this gauge measures *both product level and water interface*. At the turn of a switch the sensing element, which tracks product level, will penetrate the product to also measure water bottom. Readings of both levels can be made at the tank base or remotely on a Gilbarco Null-Balance Receiver. Gauges already installed can be equipped for this dual operation quickly, easily, inexpensively. Write for full information on the *only* gauge which gives you complete gauging automation.

Gilbarco
Gilbert & Barker Manufacturing Co.
West Springfield, Mass.
Toronto, Canada

What Suppliers Are Doing . . .

Dunn

Allistair Dunn has been named director of manufacturing operations for The Ohio Injector Co. He was formerly with Blackhawk Manufacturing Co., Milwaukee, where he held a similar post. Dunn said the manufacturing organization is being broadened to regroup management functions to include separately directed manufacturing and industrial engineering.

Dunn is a graduate of Wayne State University, Detroit. He had been in the Engineering department, Chevrolet division, General Motors Corp., before going to Curtiss-Wright and Blackhawk.

Schuck

Richard N. Schuck has been named director of the newly-formed Marketing Research department, Marketing division, Consolidated Electrodynamics Corp. Schuck has been a management consultant with McKinsey & Co., Inc., the past 36 months. Previously, he was manager of marketing research at General Metals Corp., and was a marketing research analyst with General Electric Co. He has a B.S. degree in business administration from the University of Pittsburgh and completed a three-year business training course at General Electric.

Aufmuth

Raymond B. Aufmuth has been named chief engineer, The H. K. Ferguson Co. He will direct and coordinate all Ferguson engineering activities. He was most recently a staff engineer in the Cleveland office engaged in design and construction activities in the steel industry. He joined Ferguson in 1947, serving as project engineer. In 1954, Aufmuth went to London as chief engineer for H. K. Ferguson Co. of Great Britain, Ltd. He returned to Cleveland in 1956 to become chief mechanical engineer of the firm's central district.

Major

William R. Major, Jr., has been appointed divisional manager of the Southeast division, Crouse-Hinds Co. Headquartered at Atlanta. Ga., his division includes Georgia, Alabama, Florida, the Carolinas, and most of Tennessee. Major is an electrical engineering graduate of the Alabama Polytechnic Institute. He has been with Crouse-Hinds since 1946, transferring last August from San Francisco where he was regional manager. He is a member of the Illuminating Engineering Society, and was once president of the Ben Franklin Electric Club.

Winn

Francis W. Winn, formerly technical director of Fractionation Research, Inc., Alhambra, Calif., has joined Fritz W. Glitsch & Sons, Inc., Dallas, as director of research and development for fractionation trays. He received a B.S. degree in chemical engineering from the University of Oklahoma in 1940. Prior to his work with Fractionation Research, Winn was with Pan-American Petroleum Corp., Socony-Mobil Oil Co., and Catalytic Construction Co.

Edmund W. Dugan, business manager for Chemetron Corp.'s Girdler Catalysts operation in Louisville, Ky., has been named assistant director of the General Industrial Equipment and Components division of the Business and Defense Services Administration, U.S. Department of Commerce. He is on a six-month assignment in Washington, providing technical guidance for defense mobilization of industrial resources under the Defense Production Act. Since 1956 Dugan has held various executive and administrative assignments for Girdler. He attended Indiana University.

Dugan

Donald E. Dixon has re-joined The Cooper-Bessemer Corp. Presently assigned to the company's Turbo-Compressor group, he will ultimately join one of the regional field offices with responsibility for application and sale of engines, reciprocating and centrifugal compressors. A graduate of Oklahoma A & M College, Dixon joined Cooper-Bessemer in 1952 and was later promoted to manager, Compressor section sales. From this position he was appointed to the C-B Tulsa office where he was directly responsible for field contact work in Oklahoma.

Dixon

Robert D. Enochs has been named marketing manager for analytical and control instruments, Consolidated Electrodynamics Corp. During the past year, he has been manager of the company's district office in Dallas. He joined CEC in 1951 as an installation engineer, became a training engineer in 1952, a supervisor in Instrument Order Service in 1953, and assistant to the director of sales in 1956. He is a graduate of the University of Colorado with a B.S. degree in electrical engineering.

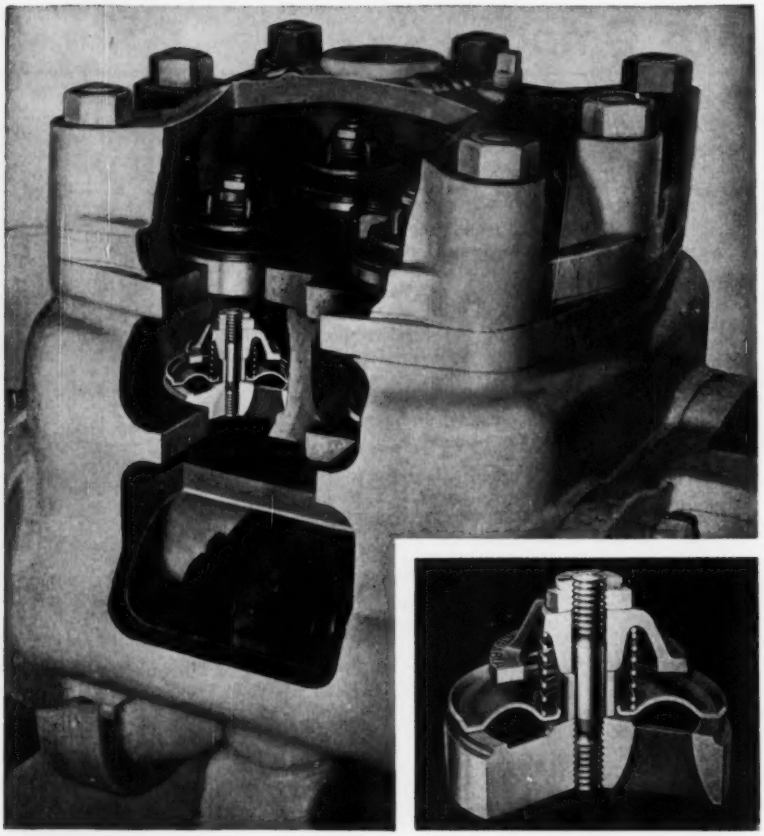
Enochs

John L. Tullis has been made president and general manager of The J. B. Beaird Co., Inc. Formerly an executive vice president, he will remain director of the Beaird Co. and a member of the board of directors, American Machine & Foundry Co. He will also head Beaird International, Inc., and the Phoenix Corp. Tullis joined the company in 1947 and became vice president of the company in 1957.

Tullis

Levin P. Handy has been appointed director of the cable unit of the Aeronautical and Instrument division, Robertshaw-Fulton Controls Co., Anaheim, Calif. Handy joined the Aeronautical and Instrument division in 1954 and served most recently as contract administrator with responsibility for acceptance and administration of all contracts received by the division. Prior to joining Robertshaw, Handy had a variety of assignments, including aircraft and

Handy



The valve for reciprocating pumps . . . old or new

Because they offer a happy combination of dependability, efficiency and extra life, DURABLA Valves are a credit to any reciprocating pump. Mechanically and metallurgically speaking, they will operate freely under temperature-pressure extremes, with highly corrosive fluids and in any position.

In a DURABLA Valve Unit, only "point contact" is made by the valve member on the sleeve, so it can't bind or hang-up. Due to its unique arched design, neither will it warp. The new V-7* taper-locked stud can be screwed down tight into the seat without any possibility of galling or breakage. And a self-locking nut and "drop-on" guard assure quick and easy inspection of working parts —without stud or seat removal.

Standard equipment on many new pumps, DURABLA Valve Units are also used throughout the world to re-valve older pumps. They come in fifteen sizes, designed to meet over 300 variations in installation requirements.

Write for new booklet PR 29.

DURABLA MANUFACTURING COMPANY
114 Liberty Street, New York 6, New York

DURABLA®

DM-34

Suppliers . . .

missile design and aviation ordance, with the Bureau of Aeronautcs, Navy Department, dating from World War II. Handy holds a B.S. degree in aeronautical engineering.

SOUTHWEST INDUSTRIES, INC., Houston, organized five years ago to provide specialized services for the natural gasoline industry, is moving into another industrial field—the design and construction of packaged plants to produce and purify inert gases. Formerly, the inert gas equipment business was concentrated in the industrial centers of the North and South. Southwest Industries now provides packaged inert gas units right in the area where the petrochemical industry and other plants using the process are centered.

The company's expansion program, recently announced, includes appointment of additional key executive personnel, and the opening of an office in Calgary, Alberta, Canada. The new executives, all professional engineers, are **E. C. Broun, Jr.,** general sales manager; **Carl J. Maki,** president of the Canadian subsidiary, Southwest-Barber, Ltd., and head of the new Canadian office; **W. F. Barstow,** industrial sales manager, and **Charles E. Richards, Jr.,** sales engineer in charge of small horsepower packaged compressors.

MINE SAFETY APPLIANCES CO. has named **Eugene J. Condle** sales engineer for Pittsburgh territory of the recently expanded Technical Products division. **John W. Moser** has been named sales engineer for the Kansas City, Mo., territory. **Gerald E. Stackhouse** has been named sales engineer for the Buffalo, N. Y., territory. They will provide de-

Chemicals Wanted

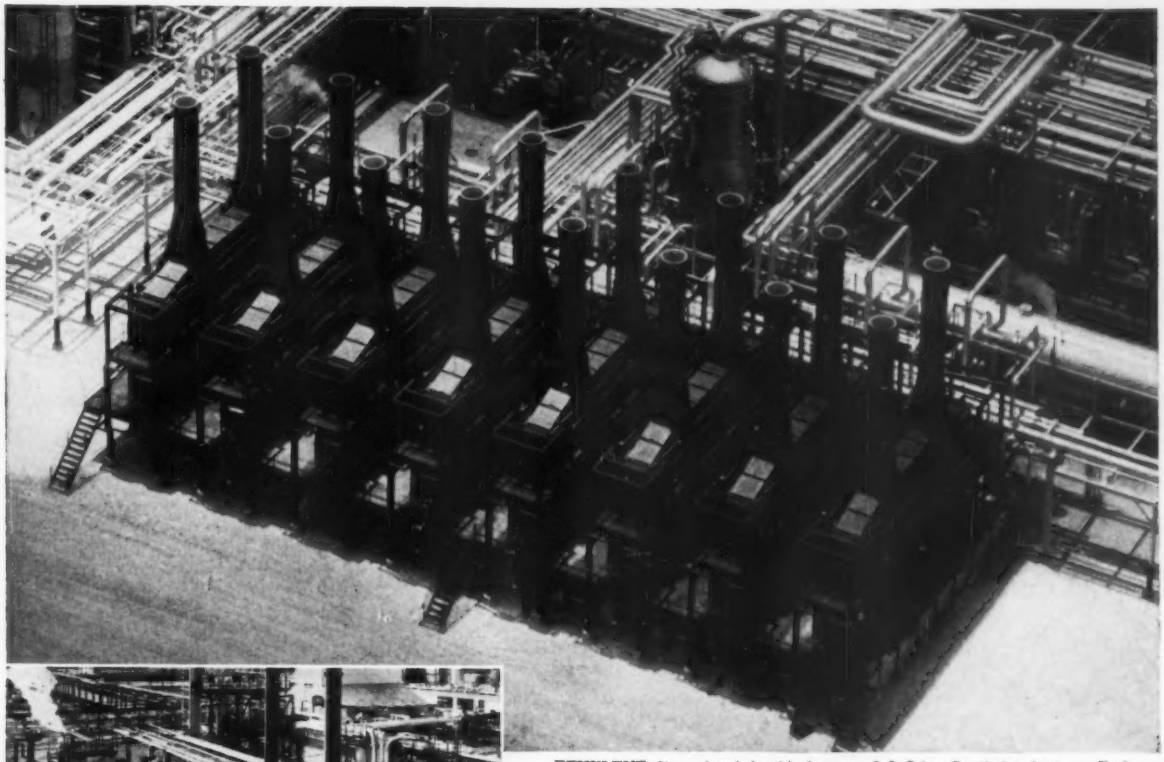
The National Registry of Rare Chemicals, Armour Research Foundation, 33rd Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the registry.

Cyclobutane
Benzenepentacarboxylic acid
1,2,3,5-Benzenetetracarboxylic acid (Prehnitic acid)
p-Chlorocumene
1-Chloro-2-methylbutadiene-1,3
2-Chloro-4-methylpentane
2,4-Dichloropentane
Dicobalto octacarbonyl
Dilauryl phthalate
3,3-Dimethyl-1-butanol
5,5-Dimethylheptene-3
N,N-Dimethyl phenylammonium iodide
2-Ethoxypropane
2-Ethyl-n-butyl chloride
4-Ethyl cyclohexanol
Furfuryl cyanide
N-Hexyl azide
2-Methyl-n-butyl chloride
Nonanol-5
Vinyl sulfide

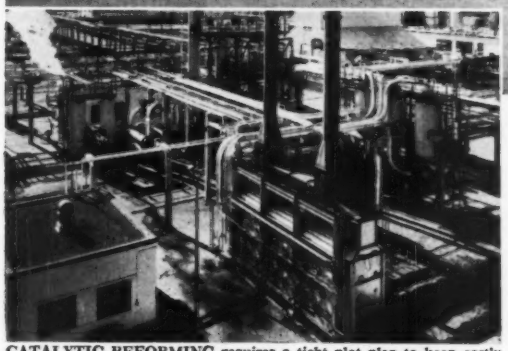
For more data on advertised products, use Readers' Service Cards, last page.

our research is your reward

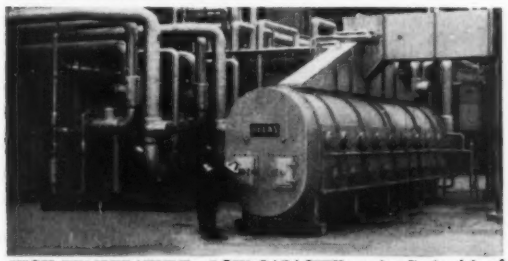
SELAS Gradiation®: heat processing for the petroleum, petrochemical and chemical industries



ETHYLENE is produced in this battery of 8 Selas Gradiation heaters. Each individual heater is capable of handling a variety of feed stocks such as ethane, propane, butane and naphtha. This installation has been in continuous service for more than 4 years.



CATALYTIC REFORMING requires a tight plot plan to keep costly transfer piping to a minimum. The Zone Control of this Gradiation heater makes possible the installation of 3 coils in a single box, all capable of independent temperature control.



HIGH TEMPERATURE - LOW CAPACITY service is the job of this barrel-type Gradiation heater. Supplied shop-assembled, it produces superheated steam in 2 separate coils ranging from 1000° to 1250°F.

Throughout the petroleum, petrochemical and chemical industries, the Selas Gradiation principle of direct-fired radiant heating brings to critical processing operations:

- Preciseness of heating
- Zone Control
- Instant response to controller demand
- Versatility

In addition, where heat capacities are small . . . even for low temperature, non-critical applications . . . barrel-type Gradiation heaters, offering all the benefits of Selas radiant heating, are competitive.

For information about Selas Gradiation heaters send for Bulletin 72 "Gradiation Heating for Petroleum and Chemical Processing." Selas engineers will be glad to discuss with you your specific heat processing requirements.

Gradiation is a registered trade name of Selas Corporation of America.

SELAS CORPORATION OF AMERICA DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION

AIRETOOL

TUBE MAINTENANCE TOOLS LENGTHEN TIME ON STREAM

Field reports show Airetool tube maintenance tools get tubular equipment back in service in as little as half the time. Result? More time on stream. There's plenty of power and stamina built into Airetool equipment. It's fast, easy and economical to operate. In many cases, one man with Airetool equipment out-produces two workers with ordinary tools. And you save additional costs because Airetool equipment restores tubular system to peak efficiency . . . extends tube life. It will pay you to call your Airetool representative or write us for free Bulletin #64. This illustrated catalog gives complete information about Airetool tube maintenance tools.

TUBE CLEANERS

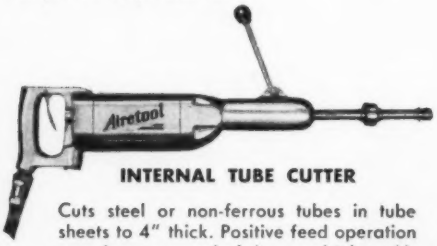
Powerful, air driven tools for removing hardest deposits in straight or curved tubes up to 24" I.D.

CONDENSER TUBE CLEANER

Cuts costs in cleaning hard scale from tubes up to 1". Lightweight, easy-to-handle. Built-in flushing system removes chips . . . keeps drill cool.

AIRETROL AUTOMATIC TUBE EXPANSION CONTROL

The fastest way to roll tight, even tube joints. Quick set torque sensing mechanism stops expansion automatically to .001" accuracy. One man easily rolls 12 tubes per minute.



INTERNAL TUBE CUTTER

Cuts steel or non-ferrous tubes in tube sheets to 4" thick. Positive feed operation speeds up removal of damaged tubes. Air or electric drive.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

REPRESENTATIVES in principal cities of U.S.A., Canada, Mexico, South America, England, Puerto Rico, Italy, Japan, Hawaii
EUROPEAN PLANT: Vlaardingen, The Netherlands
CANADIAN PLANT: 37 Spalding Drive, Brantford, Ontario
BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge

Suppliers . . .

sign assistance and counsel on the installation and maintenance of instruments and process controls for industry in their respective areas.

AMERICAN CYANAMID CO. has appointed **Richard M. Goddard** manager of its Process Chemicals department. Goddard joined Cyanamid more than 25 years ago and has served in sales and administrative posts.

NORTON CO. has elected **Donald L. Price** vice president. With the company 38 years in sales positions, he has been sales manager of grinding wheels for the Abrasive division since 1955.

KOPPERS CO., INC., will construct a new research center at Monroeville, Penn., in 1959. An administration building, three chemical laboratories, a power plant and supporting facilities are planned.

HERCULES POWDER CO.'s Philip B. Stull has resigned as a vice president and director of the company. He also resigned from the Executive committee as he plans an early retirement.

UNITED STATES STEEL CORP.'s National Tube Division has appointed **Louis W. Mason** sales manager, Eastern area, and **James G. Morrison** sales manager, Central area. Mason will headquarter in New York and Morrison will locate in Chicago.

CONSOLIDATED ELECTRODYNAMICS CORP. has appointed **Albert W. Brandmaier** director of European operations. He will manage licensing and manufacturing negotiations between CEC and companies in Europe and the United Kingdom. He will continue to direct European marketing operations.

JOHNS-MANVILLE FIBER GLASS, INC., has acquired L.O.F. Glass Fibers Co. Transfer of all assets and business was included in the move.

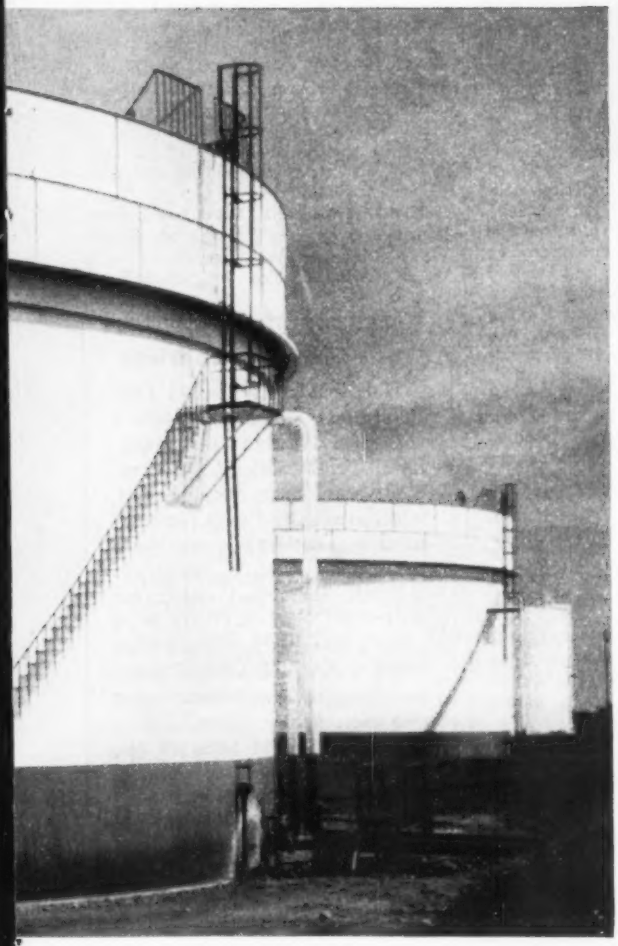
UNION TANK CAR CO. reports that Graver Tank & Mfg. Co., Inc., previously a Union Tank subsidiary, became a division of the company January 1.

CHARLES BRUNING CO., INC., has moved its Portland offices to 2136 S. W. Fifth Ave. The 8,600-square-foot area of the new branch will contain larger offices, display room, and warehouse.

THE BRISTOL CO. has named **John F. Peterson** branch manager of the Newark branch office. He joined Bristol in 1948 as a service engineer, became sales engineer in 1954, and sectional sales engineer at Syracuse, N. Y., in 1955.

AMERICAN CYANAMID CO.'s Dr. J. H. Peden has been named director of research for the Organic Chemicals division with headquarters at Boundbrook, N. J. He received a B.S. degree from the

NO ODOR to Harm Good Community Relations



AT GREAT NORTHERN'S NEW PINE BEND, MINN. REFINERY

Keeping objectionable odors from the atmosphere, while 24.1 degree API gravity Canadian sour crude is in storage, finds an effective solution in vapor-saving Graver Expansion Roof® Tank System at the new Pine Bend, Minn. refinery of the Great Northern Oil Company.

Conserving valuable light ends can be either the primary or secondary function of this famous vapor-saving tank system, depending on the acuteness of the community relations problem.

One thing is certain. There is no more effective way to keep vapors under control than with a Graver Expansion Roof Tank manifolded to cone roof tanks. Because the economics are sound, of the 39 tanks fabricated and erected by Graver at Great Northern, every tank used for storing crude or product where vapor conservation is a problem is manifolded to a Graver Expansion Roof Tank.

This is another example of how the petroleum industry for 100 years has been solving its vapor conservation—and community relations—problems with Graver's help.

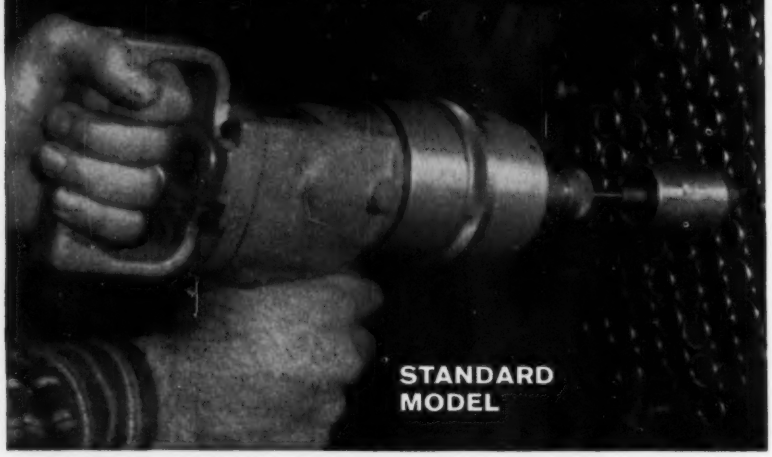
GRAVER TANK & MFG. CO.
DIVISION—UNION TANK CAR COMPANY
EAST CHICAGO, IND.

GRAVER®

Plants and Offices Across America

ELLIOTT air magnetic tube expander drives

automatically controlled for fast, accurate tube rolling



Designed for faster, precision tube rolling, the standard model Elliott Air-Magnetic drive is setting new records for speed and accuracy. Some operators average 12 tubes per minute. Desired torque easily preset by rotating forward end of unit. No tools needed. Rolling stops when preset torque levels are reached. Includes trigger-controlled, explosion-proof air motor in single unit. Magnetic control, no springs. Balanced for easy handling. For tubes ¼ in. through 3 in. *Standard model* handles most jobs. *Heavy-duty* for higher torque.

ALSO Electric Control ...Tube Expanders... and Related Accessories

Elliott offers the Automatic Electric Control—an accurate torque-limiting device designed for tube expanding with any standard tapping motor. Also, a complete line of tube expanders, with rotating, parallel, self-feeding rolls. Available in 4 sizes, ranging from ¼ in. to 3½ in. O.D.

Other related accessories include Elliott tube gage, tube plugs, tube pilot, and tube rolling lubricant.

Write for descriptive literature *today*.

YB-3

ELLIOTT Company
LAGONDA PLANT, Springfield, Ohio

Suppliers . . .

University of Illinois, M.S. degree from the University of Minnesota and his Ph.D. degree from the University of Wisconsin. He joined Cyanamid in 1937 as a research chemist.

COOPER ALLOY CORP. has named **Donald R. Hepler** vice president, manufacturing. He will direct all manufacturing divisions of the company and will coordinate the production activities.

LINDE CO. is planning a liquid oxygen plant for Gary Steel Works and Gary Sheet and Tin Mill. The new Aplant, reportedly capable of producing 3-MMcf of oxygen per day, will double oxygen capacity at Gary.

DRESSER INDUSTRIES, INC.'s Roots-Connersville Blower division is establishing a new district sales office in Houston. **Daniel Fulton,** with Roots-Connersville since 1948, will manage and organize the Houston territory.

CHASE BRASS & COPPER CO. has elected **William H. Preston** executive vice president. Preston joined Chase from Joy Manufacturing Co., Pittsburgh, where he has held several key executive positions in both general manufacturing and sales.

EGGELHOF ENGINEERS, INC., has become exclusive representative for Kunkle Valve & Gauge Co., Fort Wayne, Ind. W. C. Dillon & Co., Inc., Van Nuys,

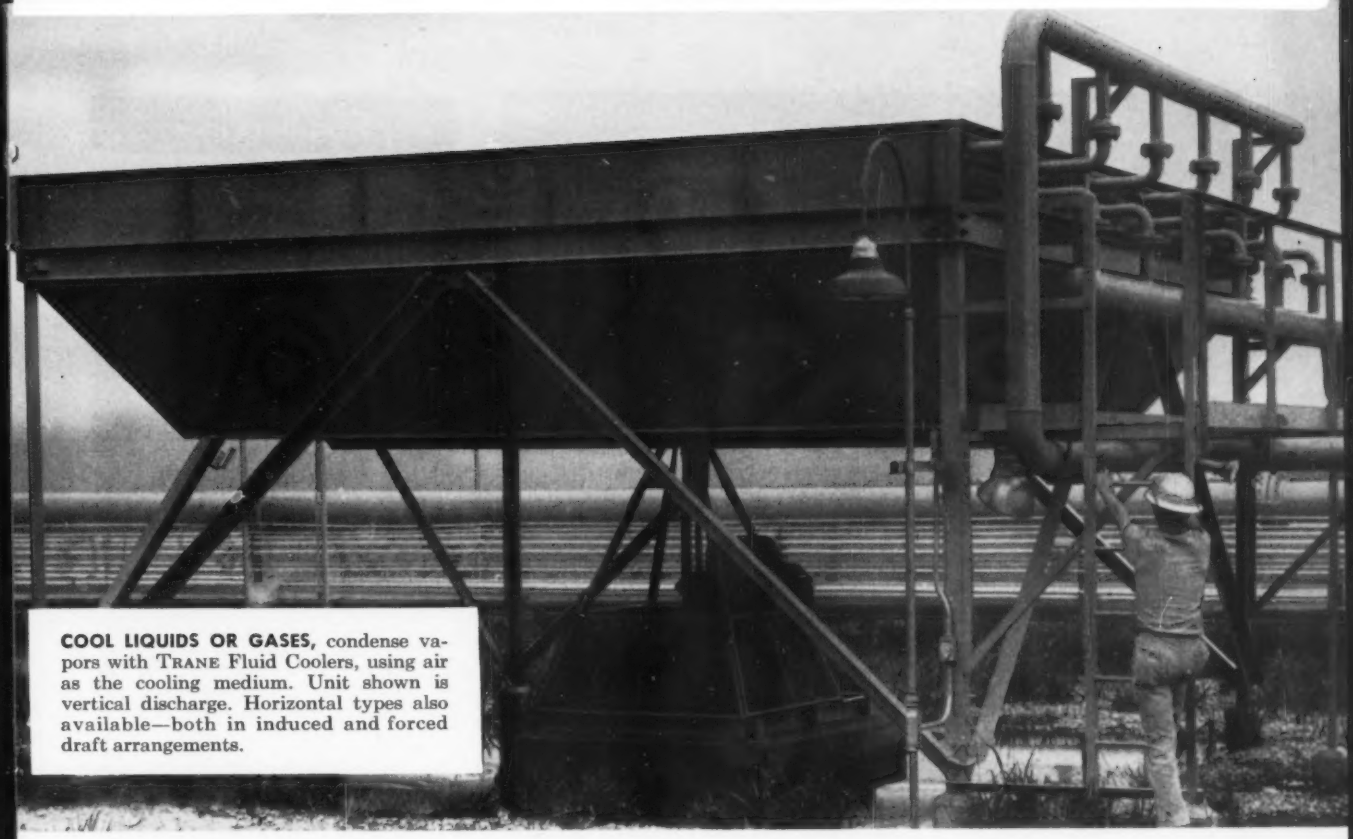
Tear Sheets—Reprints

Handling costs compel Gulf Publishing Company to make a charge of 25 cents per article for all TEAR SHEETS ordered. Such tear sheets will be sent, when available, if cash (or company requisitions) is sent with the order.

Small, individual orders for REPRINTS of articles will carry a 50-cent charge per copy WHEN AVAILABLE. Cash (or company requisitions) must also accompany these orders. The $1. price on some of our larger reprints will, of course, continue to apply.

These price rules do not affect quantity orders (starting at 100 copies) of any article printed. Prices for these will be quoted upon request.

Address: Reprints,
Petroleum Refiner,
Box 2608
Houston 1, Texas



COOL LIQUIDS OR GASES, condense vapors with TRANE Fluid Coolers, using air as the cooling medium. Unit shown is vertical discharge. Horizontal types also available—both in induced and forced draft arrangements.

Lower erection costs, operating costs ...with versatile Trane Fluid Coolers!

Air-cooling now solving water supply problems for many refineries, petrochemical and natural gasoline plants

More and more engineers and plant designers are finding that *air-cooled heat exchangers* eliminate water supply and maintenance problems encountered with conventional cooling towers. These engineers report a substantial net reduction in over-all cooling costs and water consumption. Here are some of the ways TRANE Fluid Coolers are helping to solve heat transfer problems in many refineries and plants:

- **Low first cost.** Erection is simpler; fan, motor and gearbox are factory-aligned on a single metal base. Framework parts are pre-drilled, match-marked. Compact, simple, TRANE Coolers can often be installed on roofs, cutting real estate costs.
- **Lower operating costs.** Equipment needs only periodic cleaning of fin-tube surface. No need for special crews, maintenance facilities or spare parts. And TRANE Fluid Coolers have a life expectancy of 15-20 years—compared with 7-10 years for cooling towers.
- **Superior performance.** TRANE Coolers available with Admiralty stainless and carbon steel tubing to meet the most exacting specifications. Units are now in use in Canada and Bermuda—meeting extreme weather conditions. They also solve the problem of corrosion caused by salt-air atmosphere.

WANT MORE FACTS?

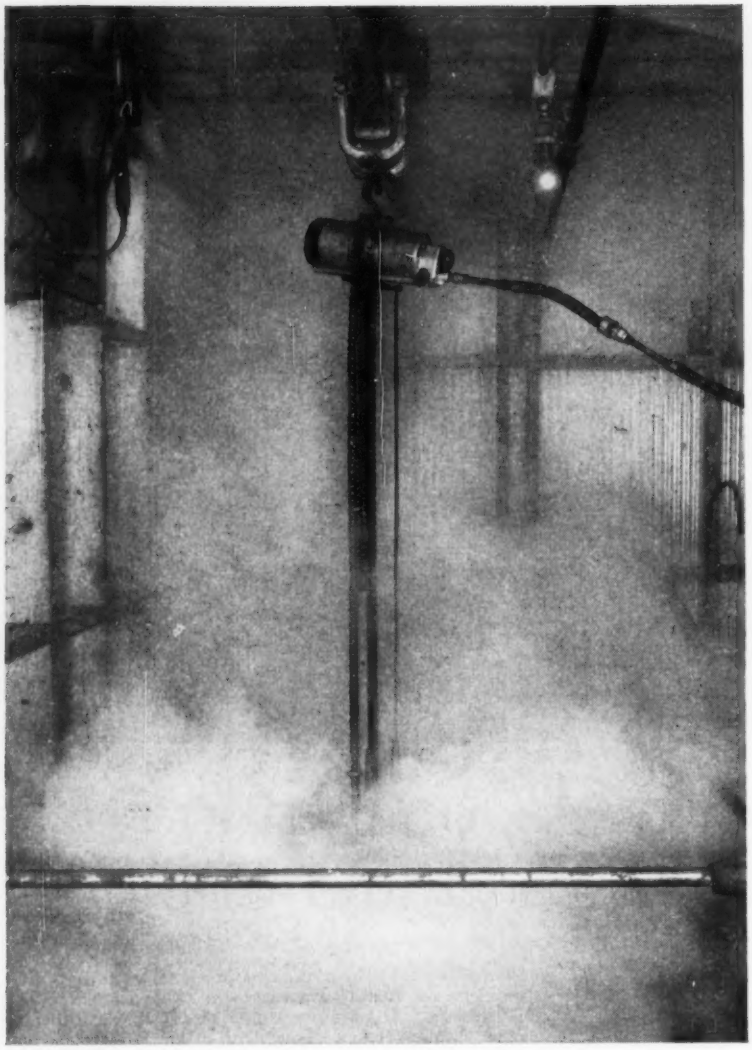
New Catalog S-395 has complete specification and application data on TRANE Fluid Coolers. For your copy, write TRANE, La Crosse, Wisconsin. Or just call your nearby TRANE Sales Office.

For any air condition, turn to

TRANE

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. • CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 97 U. S. AND 18 CANADIAN OFFICES



Air hoist runs cool
despite heat and humidity

Maintenance of processing equipment calls for steam, plus a hoist that laughs at constant heat and humidity. That's why so many chemical plants and refineries favor this ½-ton Gardner-Denver 86-1V10, air hoist (one of our complete line with capacities from 150 lb. to two tons). Reasons for this preference for Gardner-Denver hoists include: fire-safe, nonsparking operation; they provide a positive, steady lift; they possess every other feature required for easy, safe load spotting. Write for Bulletin 86-1.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

Suppliers . . .

Calif., and Customline Control Panels, Inc., Linden, N. J. The Eggelhof corporation is headed by **R. A. Molnari,** president, and **Tom H. Pierson,** executive vice president, Houston. Branch offices are in Dallas, Lubbock, San Antonio, Tulsa, Shreveport and New Orleans.

CHICAGO BRIDGE & IRON CO. has transferred **Richard D. Ayers** to the Boston office; **Robert L. Blandford** to the Tulsa sales office; **James T. Dunn** to the Philadelphia sales office, and **Donald F. Simons** to the Chicago sales office.

KAISER STEEL CORP.'s general sales office, Oakland, Calif., has named **William S. Barnum** assistant manager, Sheet and Strip sales. He has been with the Sales department since 1951.

BORG-WARNER CORP.'s Ingersoll Products division has appointed **M. R. McLary** vice president and manager and **R. L. Cain** assistant secretary-treasurer.

ARMSTRONG CORK CO.'s Industrial division has transferred **John B. Helmer** from the Cleveland district office to the Los Angeles district office. He joined the Industrial division in 1956 following graduation from Ohio State University and military service.

ARMCO STEEL CORP.'s Sheffield division has named **Robert White** manager of alloy steel sales. He has been special representative for alloy sales in Houston since April, 1957.

WESTERN COPPER MILLS, LTD., has named **J. J. Mullen** sales manager. He was production manager and assistant to the president of Ilsco Corp. for 17 years. **R. G. Nichols** has been named purchasing agent.

BLAW-KNOX CO. has begun construction of a branch plant for its Power Piping & Sprinkler division at Jackson, Miss.

NORTON BEHR-MANNING OVERSEAS, INC., has named **Frank M. Ryan** vice president and general manager. **Fordyce B.**

REFRACTORY HAYDITE

Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.
We sell direct to you.

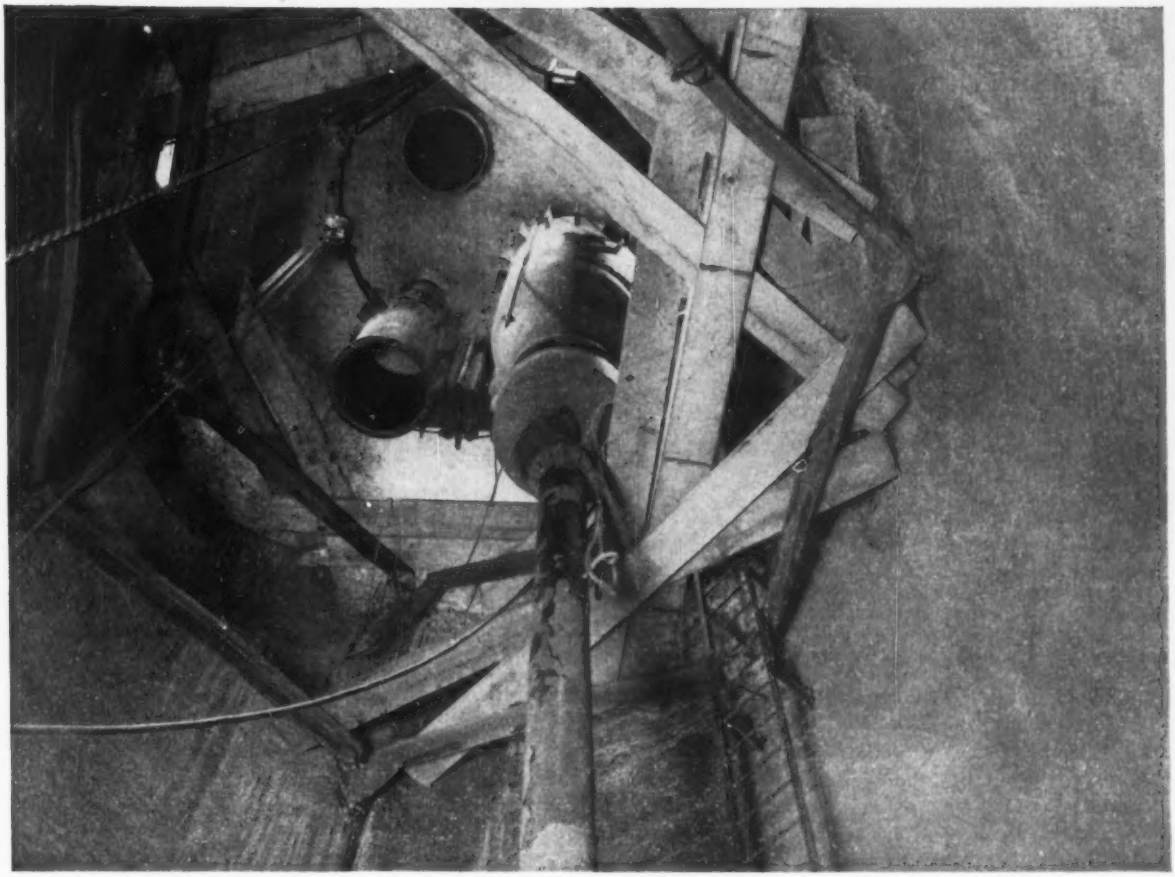
CONSTRUCTION MATERIALS
CARTER-WATERS
KANSAS CITY MISSOURI

2440 Pennway Phone GRand 1-2570

LIMITED, TORONTO • 97 U. S. AND 10 CANADIAN OFFICES

Five years later:

No repairs needed on regenerator's refractory concrete lining made with **Atlas Lumnite Cement**

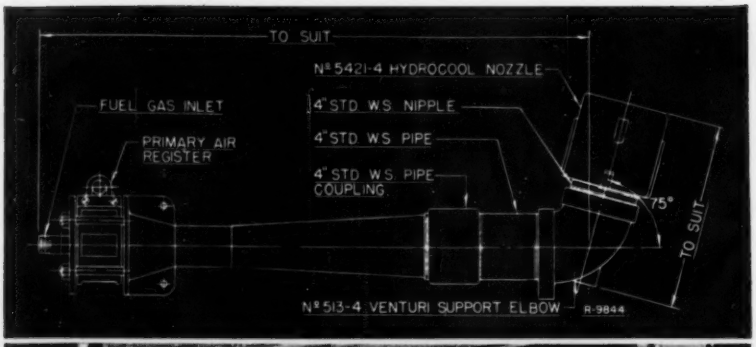


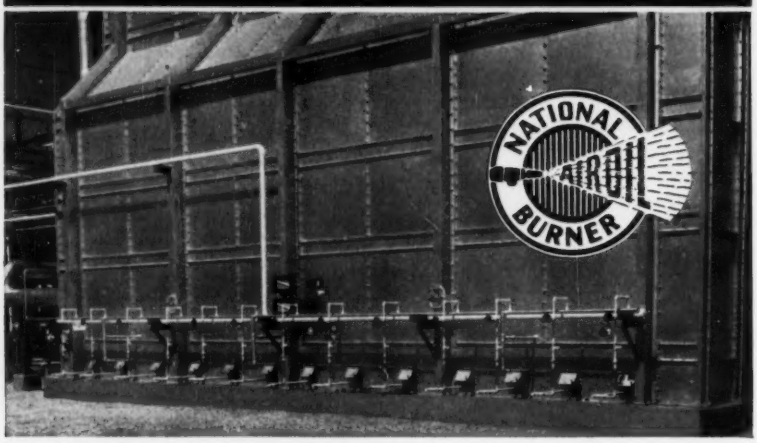
When this regenerator chamber was opened at the Canton (Ohio) refinery of the Ashland Oil & Refining Company after five years of service, the refractory concrete lining was in excellent condition. No replacement was needed. The smooth, jointless surface of the concrete, made with Lumnite calcium-aluminate cement, was free from spalling. It resisted abrasion by catalyst and the penetration of gases. In other refinery equipment (heaters, vapor separators, transfer lines, cyclones, stacks, breechings, etc.), refractory concretes made with Lumnite cement can be designed to meet every operating condition. For extra convenience and economy, castables containing Lumnite cement are available from leading manufacturers of refractories. These are packaged mixtures, requiring just water and mixing. For more information, write Universal Atlas, 100 Park Avenue, New York 17, N. Y.

"USS" and "Lumnite" are registered trademarks L-1R2

Universal Atlas Cement
Division of
United States Steel

OFFICES: Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco





Firing Hydrogen

IN A CENTER WALL UP-DRAFT FURNACE

The HYDROCOOL Burner-Nozzle was developed and is manufactured solely by National Airoil Burner Company. It provides safe operation with Hydrogen or Hydrogen rich gas fuels in any type of petroleum or chemical furnace. It will also efficiently burn any other gas, such as natural or by-product types.

As compared with the conventional natural or refinery gas burner nozzle, the HYDROCOOL will produce a short, hot, stable flame with a high turn-down ratio, and with extremely low excess air at the nozzle.

HYDROCOOL Burner-Nozzles have been in continuous large scale commercial use in oil refineries throughout the United States, Europe and the Near East.

HYDROCOOL Nozzles have frequently been used as replacements for our Airocool Nozzles, as well as other makes of nozzles where the previously high density gas has been replaced by Hydrogen.

Write us for further information — and please use your Business Letterhead.

National Airoil
BURNER COMPANY, INC.
Main Office & Factory: 1254 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.
SOUTHWESTERN DIVISION: 2512 SOUTH BOULEVARD, HOUSTON 6, TEXAS

Suppliers . . .

Scott, formerly general manager of Behr-Manning de France, comes to the company's Worcester, Mass., office as vice president in charge of sales. **Louis J. Camarra,** former European regional manager, returns to Worcester as a vice president in charge of sales.

MINE SAFETY APPLIANCES CO.'s Technical Products division has named **George T. Henderson** sales engineer for the Los Angeles territory. He has been with the company since 1937.

KENNECOTT WIRE AND CABLE CO. has become a division of The Okonite Co., subsidiary of Kennecott Copper Corp. **A. F. Sheldon,** Kennecott's head, will be administrative executive.

ARMOUR AND CO.'s Chemical division has formed two groups to handle fatty acids and aliphatic organic compounds. **Paul L. Sheppard,** recently appointed sales manager, will be responsible for fatty acid-industrial oil sales. **L. M. Miller** is sales manager of aliphatic organic compounds.

WALL COLMONOY CORP. has appointed **G. A. Barris** general manager, Stainless Processing division. He studied mechanical engineering at Lawrence Institute of Technology, and joined Wall Colmonoy in 1951.

ALLIS-CHALMERS MANUFACTURING CO.'s Industries group has named **Robert E. Claude** sales representative to the Petroleum and Chemical section, New York district. Claude joined the company in 1954 as an application engineer in the Compressor department.

ALLIED CHEMICAL CORP.'s Allied Process division vice president **Lester B. Gordon** has retired. He first began selling Solvay products in 1915. He became a vice president and director in 1951.

THE THERMIX CORP. has purchased all outstanding stock of Heacon, Inc. Thermix has represented Heacon since 1944 as sales and project engineers.

WESTINGHOUSE ELECTRIC CORP. has formed a Power Control and Communications department. **V. B. Baker,** formerly administrative assistant for the Switchgear

ABILITY
SACHSE ELECTRIC INC.
BATON ROUGE LA.

For piping systems that can't be anchored, use ZALLEA HINGED EXPANSION JOINTS

Piping systems like the one in this 63,750 bbl/day catalytic cracking unit, one of the world's largest, at Gulf Oil Corp. Girard Point Refinery, have to be entirely self supporting. The entire cracking unit . . . reactor, regenerator and all connecting lines . . . is suspended in a huge structural steel framework, counterweighted to keep the system in balance, and fitted with Zallea Hinged Expansion Joints to provide vital flexibility plus support for the reactor.

In the 150 ft. air supply line, all thermal movement of the piping is absorbed by angular displacement in three 42″ dia. Zallea Hinged Expansion Joints. Start-up air in this line is at 1000°F. Under operating conditions it is delivered at 250°F, 25 psig.

Two 50″ dia. Zallea Hinged Expansion Joints in the spent catalyst line carry fluidized cracking catalyst at 950°F, 13 psig.

Since this cracking unit first went on stream, these Zallea Expansion Joints have given completely trouble-free service.

Process piping of any kind can be fully protected with one or more Zallea Expansion Joints. From the complete Zallea line you can select the expansion joint or combination of expansion joints best suited to your particular problems.

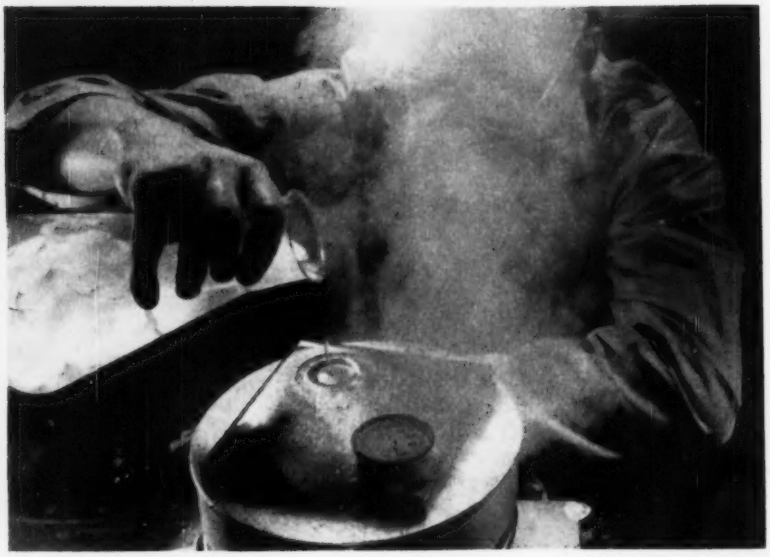
Get the complete story in our new 72-page manual. Write today, on your company letterhead, for your copy of Catalog 56. Zallea Brothers, 890 Locust Street, Wilmington 99, Delaware.

Zallea expansion joints

Zallea Brothers • Wilmington 99, Delaware

World's largest manufacturers of expansion joints

FLUI



FLUIDICS AT WORK

Thermal shocking news about new Glasteel 59

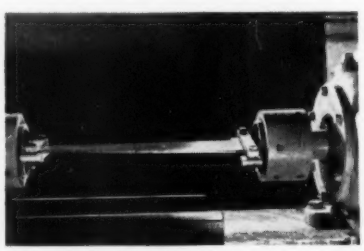
The man in the picture is pouring iced water on a hot Glasteel 59 plate, giving it an instantaneous thermal shock at 450°F. The glass stays completely unmarred. Our process equipment has a safety factor of three, so Glasteel 59 now gives you 150°F. thermal shock resistance at the peak operating temperature.

How corrosion resistant is it? Of all the many acids you might use, none will corrode Glasteel 59 except hydrofluoric.

You can also use most mild alkalies with Glasteel 59 without corrosion. For harsher alkalies, we can provide special Glasteel formulations.

How strong is it? We twisted this Glasteel bar a full 14° . . . well beyond the elastic limit of the steel. The glass-to-steel bond and the glass itself remained unbroken.

What equipment can you get in Glasteel? Just about any piece of process equipment you can name can be made by Pfaudler with Glasteel 59 . . . whether it be a giant reactor for isomerization or simple tanks for storage or pipes for fluid transfer.



For details, circle "A" on the coupon.

FLUIDICS AT WORK

First really big tantalum reactor completed

You've just looked at the first production size tantalum reactor ever made. It's a 30-gallon unit and marks still another step forward in the FLUIDICS program of studying and working with any metal or alloy that solves a corrosion problem.

Tantalum has an all-around corrosion resistance . . . it's unaffected by most acids. Tantalum will also withstand exceptionally high pressure and temperature limits. This particular unit works up to 500 psi at 650°F.

To get optimum corrosion resistance with minimum cost, we've developed a special design for these reactors. They consist of a stainless steel shell with an inserted tantalum liner. For more details, circle "B" in the coupon.

DICS

is a Pfaudler Permutit program providing

the know-how
the equipment
and the experience

for solving problems involving fluids. FLUIDICS covers such varied phases of fluid handling and control as:

corrosioneering
water treatment
waste treatment
reactions
isomerization
polymerizations
ion exchange
fluid analysis, metering and control
agitation
evaporation
distillation
blending
metering
valving
flow rate control
piping
storing
centrifuging
filling
heat transfer

Whenever you have a fluid-handling problem, look to this Pfaudler Permutit FLUIDICS program for the best solution.

FLUIDICS AT WORK

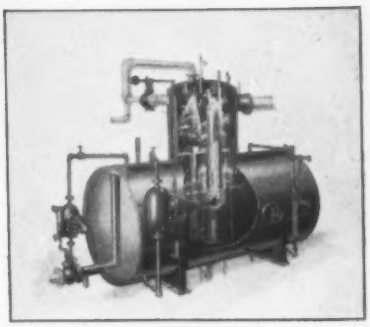
New welding methods make big titanium and zirconium heat exchangers possible

It takes talented hands to work safely with zirconium and titanium . . . which is one of the reasons you may have had trouble getting large pieces of equipment made from these metals *up to now.*

We've developed a number of methods and talents which now make it possible for you to get equipment as large as the heat exchanger being worked on in the picture above.

This zirconium heat exchanger has 134 sq. ft. of transfer area. It contains sixty-four zirconium tubes in a 21" shell 8' long. It now forms the calandria section of an evaporator for concentrating hydrogen peroxide solutions.

If you'd like to know more about what our FLUIDICS program can do for you with these metals, circle "C" on the coupon.



FLUIDICS AT WORK

New deaerator scrubs water to 0.005 ml/l of oxygen

If you're looking for a way to free water almost completely of gases, you'll look far before you find a more efficient unit than this Permutit Type B deaerator.

You can push as much as 150,000 lbs/hr through one of these and reduce the oxygen content to as little as 0.005 ml/l.

Our Type A deaerators handle up to 3,000,000 lbs/hr, if you're interested in really large capacity.

Both types are available in either horizontal or vertical designs.

For details, circle "D" on the coupon.

PFAUDLER PERMUTIT INC. PFAUDLER DIV., DEPT. PR-29, ROCHESTER 3, N. Y.

Circle item wanted: A, B, C, D

Name.....

Title.....

Company.....

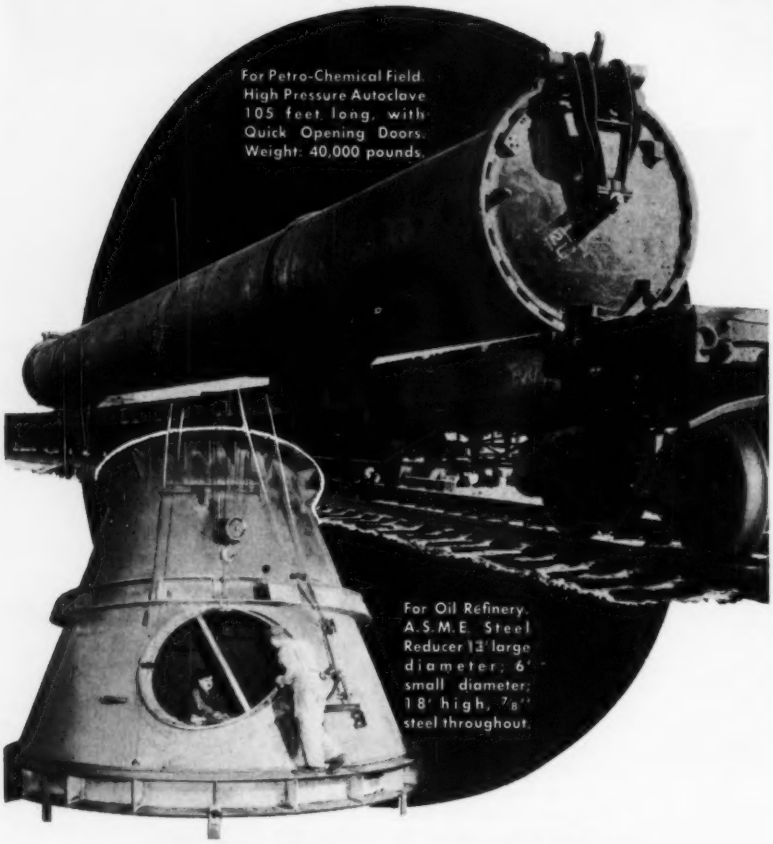
Address.....

City..... Zone..... State.....

75 YEARS CREATING FOR TOMORROW Pfaudler

For more data on advertised products, use Readers' Service Cards, last page.

If Koven Made it's well made


For Petro-Chemical Field. High Pressure Autoclave 105 feet long, with Quick Opening Doors. Weight: 40,000 pounds.
For Oil Refinery. A.S.M.E. Steel Reducer 13' large diameter; 6' small diameter; 18' high, 7/8" steel throughout.

FOR QUALITY CONTROL

- **x-ray inspection.**
- **mass spectrometer testing.**
- **penetrant dye checking.**
- **magnetic particle inspection.**

Koven equipment in all metals and alloys includes: High pressure vessels built to A.S.M.E. Codes; extractors; mixers; stills; kettles; tanks; stacks; breechings; hot transfer lines; large diameter fabricated piping and plate exhaust ducts; shop and field erected storage tanks.

SPECIALISTS IN INTRICATE FABRICATION USING: STAINLESS STEEL • ALUMINUM • MONEL • NICKEL • INCONEL • ALL CLAD MATERIALS • NICKEL PLATED STEEL

Fabrication to all A.S.M.E. Codes

Members of Steel Plate Fabricators Association ● **See Sweet's Catalog File and Chemical Engineering Catalog**

Call or write for a consultation with a trained KOVEN representative and send for Bulletin #550.

Telephone: New Jersey: FOxcroft 6-0400 New York: WOrth 4-7395

Koven FABRICATORS, INC.

93-P East Dickerson Street, Dover, New Jersey

Suppliers . . .

Apparatus departments, will be manager. The department will consolidate a number of related activities now carried on at the East Pittsburgh and Halethorpe operations.

ALLIS-CHALMERS MANUFACTURING CO. has appointed **Earl R. Narum,** manager of automotive industry sales; **Roy E. Goodwill, Jr.,** manager of general industrial sales, and **Kenneth Womelsdorf,** sales representative, all in the Detroit district.

THE LUBRIZOL CORP. has returned **John L. Palmer** to the Engineering division as assistant division head. Since 1955 he has been manager of the Domestic Sales department.

James B. Irwin has been named manager of the Domestic Sales department. He was formerly with Monsanto Chemical Co.

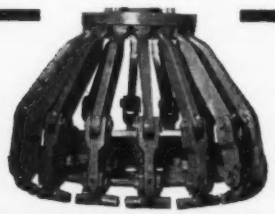
Dr. George R. Norman has been assigned temporarily to the Sales division. He had been in charge of the Product Application department, Research division.

Francis X. Sieloff, Detroit technical representative has been assigned to the Engineering division to work with equipment manufacturers in the Detroit area.

John B. Newton has been transferred to the Sales department, Lubrizol International. He had been in the Engineering division.

GENERAL CONTROLS CO. has established a European subsidiary in Dusseldorf, West Germany. General Controls, G.m.b.H, will act initially as distribution center for Continental Europe.

ALLIS-CHALMERS MANUFACTURING CO.'s Industries group has named **Harry L. Falck** manager of petroleum and chemical sales of the Los Angeles district, and **William G. Honsaker** has been named a district sales representative.



BARRETT automatic

Filling and Crimping Equipment

for handling greases and other viscous fluids.

- **No operator required.**
- **100% air operated.**

Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.

BARRETT
Manufacturing Co.
P. O. Box 8096, Houston 4, Texas

For more data on advertised products, use Readers' Service Cards, last page.

This centrifugally cast Reformer Tube with argon shielded weld is stronger than any wrought tube

X-ray inspection of weld

Thermalloy® Reformer Furnace Tubes are centrifugally cast in sections to specified diameters . . . to insure greater strength and density, finer grain structure and uniform thickness.

Individual tubes are given air and hydrostatic pressure tests. Weld quality is guaranteed by fluid penetrant and X-ray inspection. Complete assemblies receive another air and hydrostatic test. These tests provide protection against premature weld failures and against leaks at temperatures of 1800°F. and pressures exceeding 150 psig.

Electro-Alloys sales engineers can help you to select the grade of heat-resistant Thermalloy best suited to your particular operating conditions. Call your nearby representative, or write Electro-Alloys Div., American Brake Shoe Company, 1032 Taylor Street, Elyria, Ohio.

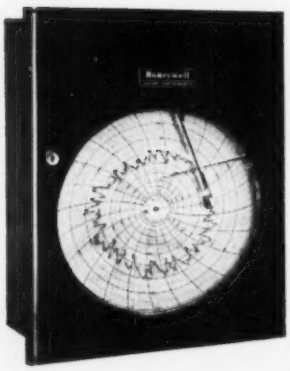
AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION • Elyria, Ohio

For more data on advertised products, use Readers' Service Cards, last page.

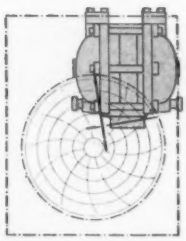
Honeywell Bellows Flow Meter

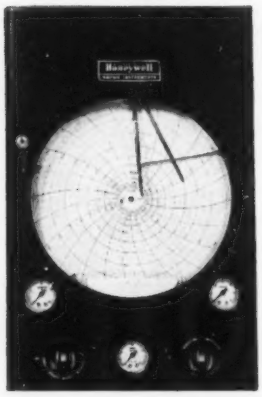
HERE ARE FOUR OF MANY WAYS YOU CAN USE THE BELLOWS FLOW METER



For direct measurement and control

the meter is integrally mounted on indicators, indicating controllers, recorders, or recording controllers.



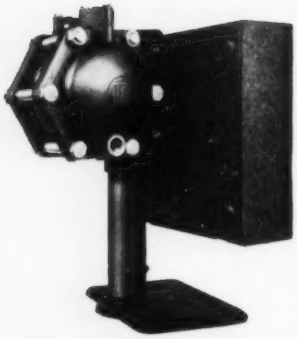


With an indicator or recorder—Indicators can be supplied with or without pneumatic transmission. Recorders can be one, two or three-pen instruments, with the second and third pens actuated by thermometer and/or pressure elements.

With indicating or recording controllers—All indicators and recorders can be supplied with any pneumatic control form from on-off to three-mode. Indicating controllers are also available with pneumatic transmission.

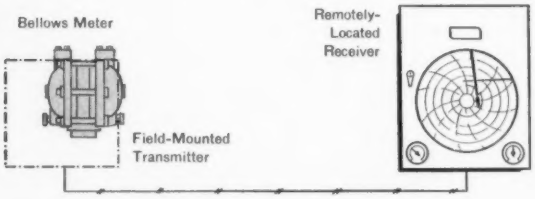
With a "blind" transmitter—the non-indicating differential pressure transmitter is used when indication is not required at the process and the variable is to be transmitted to remotely located instruments.

With an indicating transmitter—Scale is graduated in accordance with the flow or liquid level span of the transmitter. These transmitters are available with pneumatic control to remotely operate final control elements.



For remote measurement and control

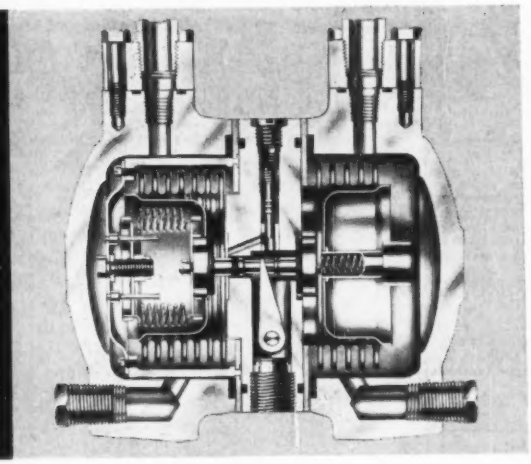
Field-mounted transmitters, either "blind" or indicating, can be used with remotely located indicators, recorders, and controllers.



and with Tel-O-Set miniature instruments and a variety of options!

has applications unlimited

Unequaled for accuracy, stability, versatility in flow and liquid level metering



Transfer of liquid between opposing high and low-pressure bellows converts differential pressure measurement into motion. A torque tube assembly carries the motion outside the meter body to an instrument. Therefore, changes in differential pressure change the instrument reading.

Here's the most advanced meter body available today, with advantages never before found in flow and liquid level meters. Combine the new Honeywell Bellows Flow Meter with the instruments shown on the facing page for truly superior service in metering steam, water, gas, oil and other fluids.

Some of its outstanding features:

Sensitive and accurate—Sensitive to within 0.5% of full scale . . . calibrated accuracy ±0.5% of full scale.

Leakproof—Between liquid fill and process fluid.

Automatically stabilized—Changes in meter body temperature or static pressure have no effect on output shaft position. Meter operates efficiently in ambient temperatures of minus 40°F to plus 250°F.

Unmatched convenience features—Including fast range changing in the field . . . connections for both horizontal and vertical piping . . . quick calibration and adjustment . . . easy cleaning and servicing.

High corrosion resistance—Seamless, stainless steel formed bellows give long, trouble-free service with virtually all process fluids.

Fast, effective damping adjustment—New type pulsation check with rectangular orifice permits essentially linear damping adjustment . . . and adjustment from outside the meter body during operation.

Models are available in many ranges, for both flow and liquid level measurement and control. Get details on *all* the features of the new Honeywell Bellows Flow Meter by calling your nearby Honeywell field engineer today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA: Catalog C22-1**

Honeywell

H HONEYWELL *First in Control*

Petroleum Refiner Classified Ads

Petroleum Refiner New Classified Rates

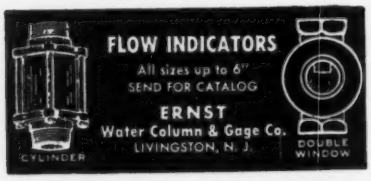
RATES: Regular Classified (undisplayed) set in this type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border, $12.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

FOR SALE

Specify SAUEREISEN
ACIDPROOF CEMENTS—COMPOUNDS
FOR
Tanks, Sewers, Stacks, Floors
Technical cements for all purposes.
Send sketches or samples
Sauereisen Cements Company · Pittsburgh 15, Penna.

When you see a large chimney think of Sauereisen Cements.



■ Sales: Engineered Equipment To Refining and Petrochemical Industry. Technical background. Established 20 years Tulsa. Expansion Oklahoma, southern Kansas, Texas Panhandle proposed. Answer Box 307-R, PETROLEUM REFINER, Houston, Texas.

■ CLEANING EQUIPMENT—for plant maintenance and tank cleaning. Hot "jet-stream" cleaning with Sellers Hydraulic Jets. Send for Bulletin 424-B Sellers Injector Corp., 1603-L Hamilton Street, Philadelphia 30, Pa.

SITUATION WANTED

Petrochemical Plant Production Supervisor, 14 years experience as chief operator and shift supervisor in hydrocarbon oxidation, synthetic fuel manufacture and chlorinated products. Presently employed, mid west, desire relocation, Gulf Coast. Please mail inquiries to Box 310-R, PETROLEUM REFINER, Houston, Texas.

WANTED

■ PETROLEUM REFINER back issues and files wanted to buy for cash, also other technical journals. P. R. Ashley, 27 East 21, New York 10, N. Y.

HELP WANTED

PETROLEUM REFINERY
CHEMICAL ENGINEERS
APPLIED MATHEMATICIANS

For expanding technical activity engaged in consulting-type service to petroleum refiners. Positions involve a wide variety of projects in sales, research, refining, and company management. Excellent opportunities for persons with either or both of the following backgrounds:

A few years of refining industry experience in process engineering or economic analysis.

Experience in applications of linear programming, statistics, or electronic computing.

These positions afford professional contact with refining and process companies throughout the petroleum industry, and provide opportunity for using initiative and individual expression to increase responsibility. Detroit suburban location.

Send resume to:

Personnel Manager
ETHYL CORPORATION
1600 W. 8 Mile Road — Ferndale 20, Michigan

■ PETROLEUM ANALYST. Graduate chemist or chemical engineer with experience in a refinery or petroleum research laboratory wanted by a research corporation located in Florida, to perform analysis and treatment of crude oil, and research and development work on new equipment. Salary commensurate with experience and background. Excellent opportunity. Send photograph and complete resumé of experience, education, and salary requirements to Personnel Department, P. O. Box 2239, Tulsa, Oklahoma.

■ SALES ENGINEER for Radioactive Sources & Tracers and equipment to Petroleum & Chemical Industry in Louisiana, Texas, Oklahoma area. Need experienced capable man. Box 309-R, PETROLEUM REFINER, Houston, Texas.

REFINERY & CHEMICAL PLANT MEN . . .
FOREIGN JOBS OPEN NOW

Safety Engineer: Age open. Single. 5 years refinery or chem. plant experience required.

Plant Manager: Salary open. Must have 10 years experience in chem. plant operation.

Asst. Plant Manager: Same as above with less experience required.

Many Plant Operators: Good salaries. Refinery or chem. plant experience required. Field electricians in particular demand.

Engineers: Always in demand. Excellent salaries. All types needed.

All inquiries confidential.

Send resume to . . .

LOVELESS Personnel
616 S. Main • Tulsa, Oklahoma

Classified Ads Don't Cost . . .

They Pay

NEW BOOKS

Liquefied Gas Transfer

"Single Phase Transfer of Liquefied Gases" has been released by the National Bureau of Standards. The greatly increased use of liquefied gases by both governmental and industrial activities has prompted an examination and re-evaluation of the basic problems connected with their handling. The current method of transporting liquefied gases over distance exceeding a few hundred feet is by mobile, insulated transport vessels. This circular examines, in detail, the feasibility of transporting liquefied gases, over appreciable distances through piping systems.

A close-form solution for the mathematical equations for incompressible flows is obtained and discussed. Information required for numerical computations involving helium, hydrogen, nitrogen, and oxygen is given in graphic form. The numerical solutions for three general problems involving hydrogen and oxygen are obtained.

(Jacobs, Robert R., *Single-Phase Transfer of Liquefied Gases (National Bureau of Standards Circular 596)*, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D. C., 42 pages, $.30.)

API Turbine Specification

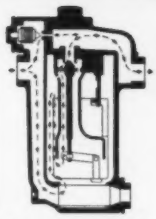
"Mechanical-Drive Steam Turbines for General Refinery Services," a tentative standard, is available from the American Petroleum Institute. This specification is intended to cover the minimum requirements for horizontal, vertical, condensing or noncondensing mechanical-drive steam turbines used in general refinery services, where maximum initial steam conditions will not exceed 850-psig pressure or 750 F. total temperature, and speeds will not exceed 12,000 rpm. This publication is based on the accumulated knowledge and experience of petroleum refiners and turbine manufacturers. It provides a purchase specification to facilitate the manufacture and procurement of turbines for refinery service.

(API, *Mechanical-Drive Steam Turbines for General Refinery Services, (Tentative Standard 615)*, Publications department, American Petroleum Institute, 50 West 50th St., New York 20, N. Y., 28 pages, $1.50.)

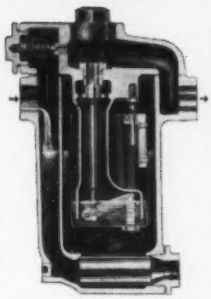
ERRATUM

In the January, 1959, issue, page 240, it was reported that the book "The Unfired Pressure Vessel Code Simplified," by Robert Chuse, is available at $1.00 per copy. Actually, the price is $6.50 per copy and $1.00 each for single charts. Orders may be placed with Robert Chuse, P. O. Box 91, Leonia, N. J.

Now—A Steam Trap that Adjusts Automatically to Every Operating Condition!



Warm-up speeded by discharge through by-pass as well as main orifice.



In-line installation. All parts serviced without removing body from line.

AUTOMATICALLY REGULATES FOR FASTER WARM-UP AND TO KEEP OPERATING TEMPERATURE AT PEAK HEAT

Proven bucket design with built-in accessories. By-pass thermostat increases discharge for warm-up and overload conditions. Thermostat compensated to operate at 10° below saturated steam temp. Wright-Austin Airxpel principle provides for mechanical discharge of air after Thermostatic by-pass has closed.

WRITE FOR BULLETIN 808

WRIGHT-AUSTIN COMPANY

3245 WIGHT STREET • DETROIT 7, MICH.

200 NEW SURPLUS VALVES

6" Valves: Semi-Steel, 500 lb. pressure W O G, Gate Double Disc, flanged, 250 lb. ASA drilling, non-rising stem with adapter for grooved pipe, gaskets for 100 Octane Gasoline, bolted on, bronze mounted.

ALSO: WIRE ROPE

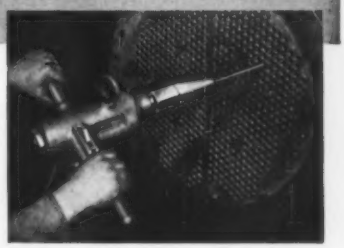
65 Reels 1" Diameter 6x37 I.W.RC—1000 Ft/Reel Beth. Steel Mfg.
2 Reels ⅞" Diameter 6x37 I.W.RC—7000 Ft/Reel
4 Reels ⅞" Diameter 6x37 I.W.RC—4000 Ft/Reel
Prices Furnished Upon Request

Oceanways Trading Corporation

Exporters of General Merchandise
25 ELIZABETH STREET, NEW YORK 13, N. Y., U.S.A., PHONE WO 6-5120

Keep Heat Exchangers on the Line with WILSON Maintenance Tools

Heavy-Duty TP-301 Cleaner



Positive air-driven, hollow rotary shaft, drill type tool. Tube is scavenged with air or water while cleaning.

Tube Expanders

Wilson Models 41 and 44 Tube Expanders incorporate an improved, adjustable ball bearing thrust collar and are designed for efficient, easy rolling and maximum roll length adjustment for various tube sheet thicknesses.

Torq-Air-Matic Expander Control

New Wilson Torq-Air-Matic is the first and only air-driven tube expander drive that accurately controls tube expansion by directly measuring torque output at the mandrel.

Tube Cutter

Wilson tube cutter is easy to use and does a fast job. Cutter sizes and shanks available to meet all heat exchanger requirements.

Write today for your copies of Wilson Tube Cleaner catalog No. 77 and Wilson Tube Expander catalog No. 88.

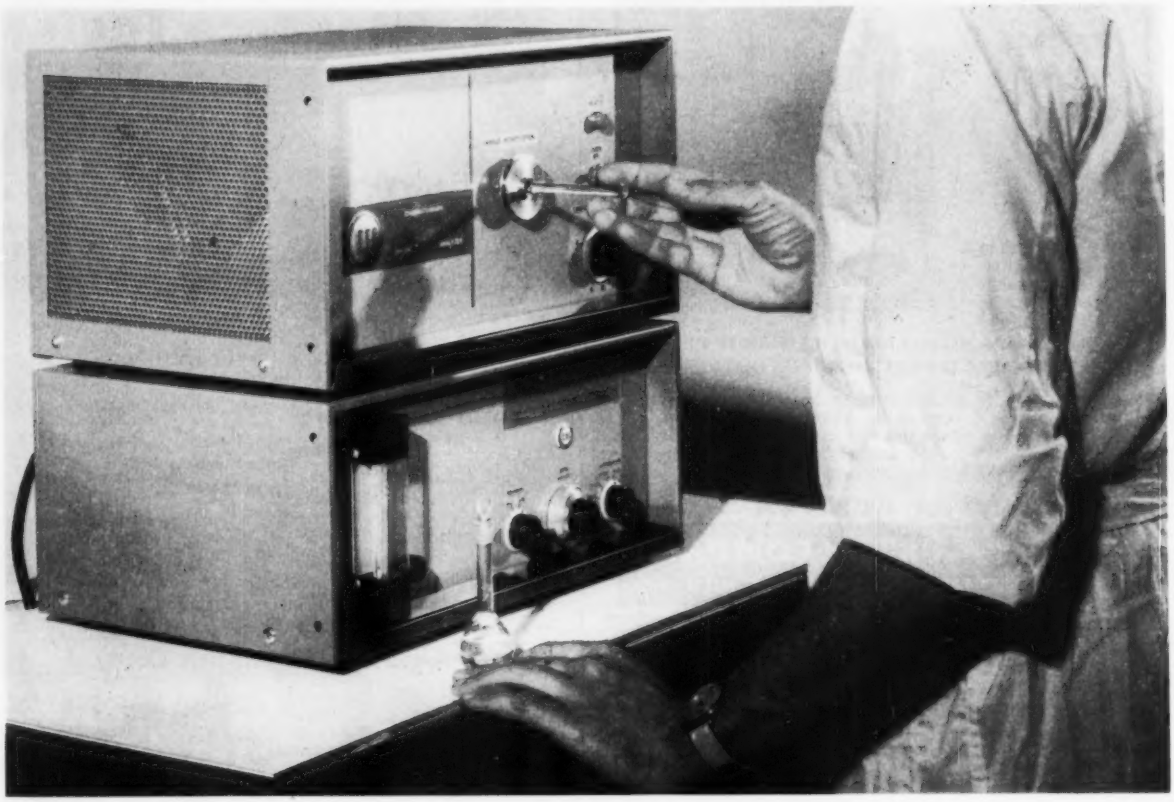
Representatives in principal cities
Thomas C. Wilson, Inc. • 21-11 44th Ave., Long Island City 1, N. Y.
Cable address: "Tubeclean", New York

WILSON TW666

TUBE CLEANERS • TUBE EXPANDERS

What's New in Equipment . . .

. . . and Manufacturers Literature



New High-Temperature Chromatograph

Designed especially for laboratory analysts and researchers, it handles standard analyses above 50 C

A new high-temperature chromatograph capable of separating and analyzing substances with boiling points up ot 600 C has just been announced. Known as the Type 26-203 High-Temperature Chromatograph, it has a maximum operating temperature of 500 C, which is beyond the range of conventional chromatographs. This is sufficient to vaporize samples with boiling points up to 600 C. It is especially designed for laboratory analysts and researchers, particularly in the petroleum, petrochemical, and chemical industries.

In performing quantitative analyses of gases, liquids, and solids by the elution method, the chromatograph readily accommodates high-molecular-weight waxes, oils, plasticizers, silicone oils, fatty acids, biphenyls, terphenyls, glycols, phthalate esters, nitriles, and diglycerides.

In addition to high-temperature applications, the 26-203 may be used as a general-purpose laboratory instrument for all standard chromatographic analyses above 50 C. It is fast and easy to operate.

Its performance at high temperatures is made possible through heat-shielding design and heat-resistant materials in the analyzer. The heat sink is composed of a special bronze alloy that will not corrode at elevated temperatures. Seals on the detectors are made of Ceramicite, a high-temperature insulating and vacuum-sealing compound, and the entire oven assembly is insulated and ventilated. Temperatures can be regulated within ± 0.5 C.

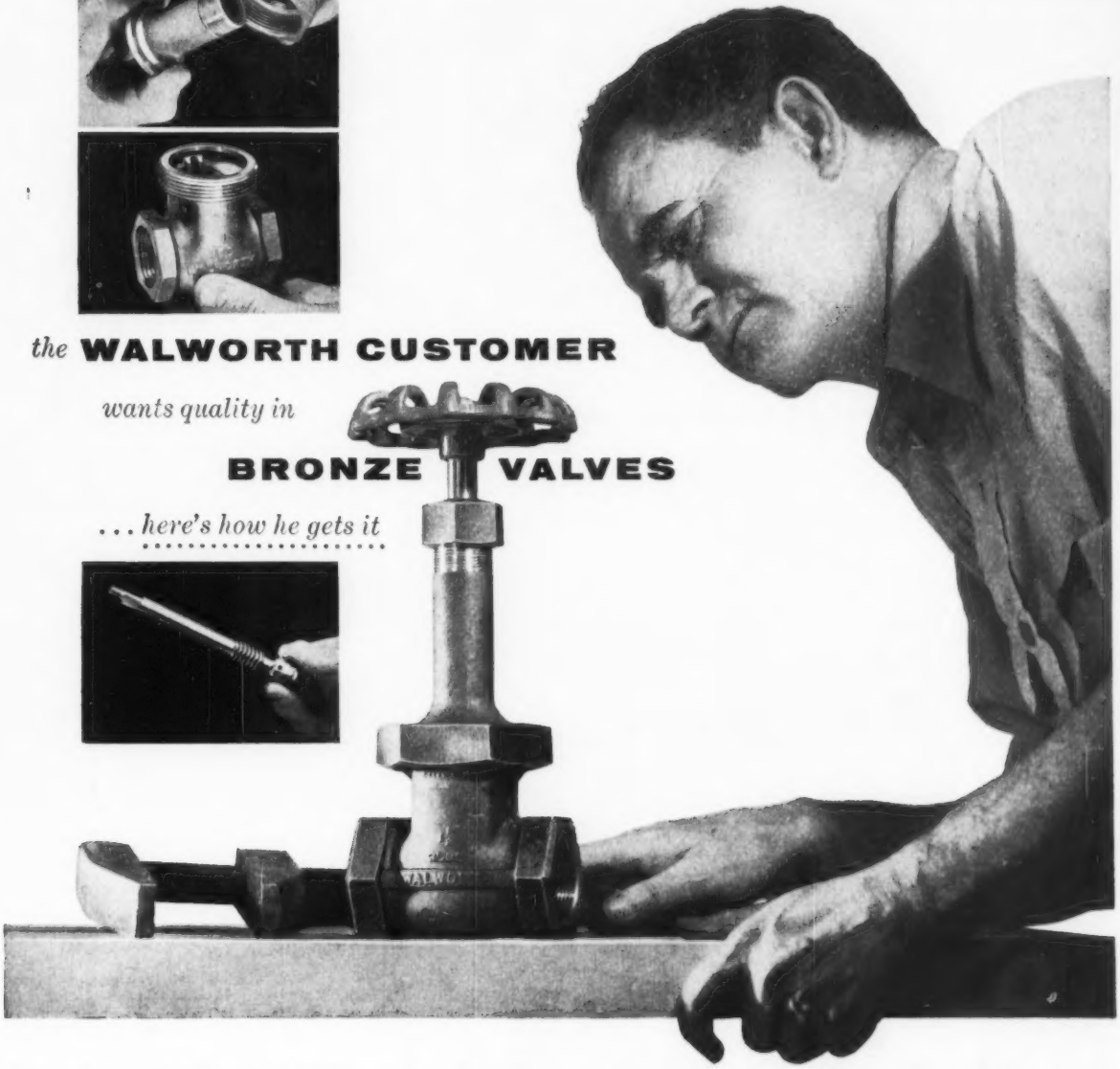
Modular design makes it possible

the **WALWORTH CUSTOMER**

wants quality in

BRONZE VALVES

. . . here's how he gets it



When he needs Bronze Valves, the Walworth Customer grabs a wrench. He wants to *see* the quality. He examines body construction for wall thickness. He looks at stems for length and depth of threads. In Walworth Bronze Valves, the Walworth Customer finds a union body-to-bonnet construction which means easy disassembly. It means no leakage, even after many take-downs and reassemblies. He finds extra-large stems, with extra-long, extra-deep threads. That means protection against wear, and tight, positive shutoffs. With these facts in hand, he buys.

You, too, may be insistent on having your valve facts first-hand, and being certain of long life and minimum maintenance. If those are your buying habits, we'd like you for a Walworth Customer, too. For full information about the complete line of Walworth Bronze Valves and Fittings, ask your Walworth Distributor.

Or write **WALWORTH** *750 Third Avenue, New York 17, N. Y.*

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

WALWORTH SUBSIDIARIES: ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO. M&H VALVE & FITTINGS CO. • SOUTHWEST FABRICATING & WELDING CO., INC. • WALWORTH COMPANY OF CANADA, LTD.

For more data on advertised products, use Readers' Service Cards, last page.

to expand the instrument as analytical needs change. Several analyzer units may be operated from a single control unit, and since each analyzer can employ a different type column, the change-over from one type sample to another can be accomplished rapidly. Consolidated Electrodynamics Corp.

Circle E1 green card, last page

Booklet Describes How To Evaluate Chemical Reactions

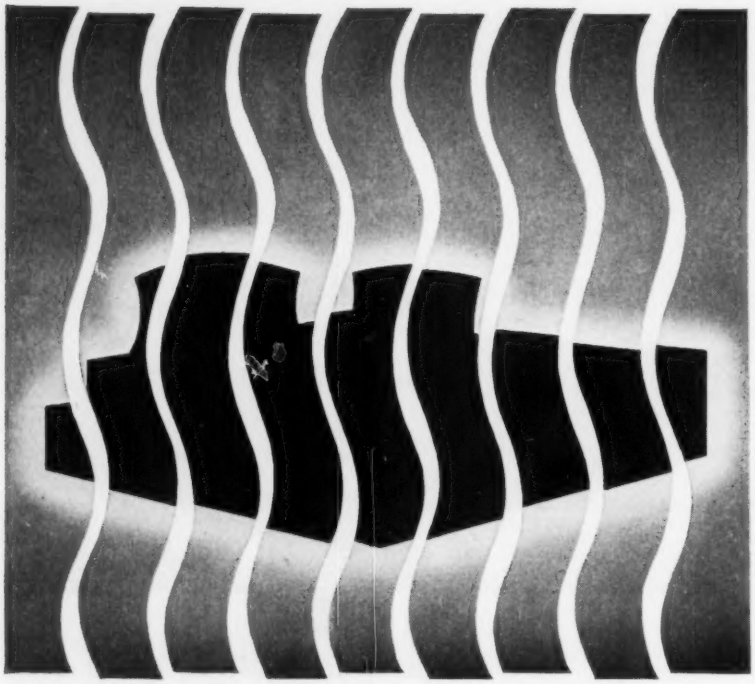
Data useful in evaluating the course of many chemical reactions is provided in a new edition of a 40-page booklet, "Physical and Thermodynamic Properties of Elements and Compounds."

The booklet includes listings of enthalpies and heat capacities of many common elements and compounds, equilibrium constants for several common reactions and information for computing equilibrium constants for other reactions, values of many constants, conversion factors, steam tables and the periodic table.

Additions to the revised edition include enthalpies, heat capacities and equilibrium constant information for three gases—propadiene, methyl acetylene and cyclohexane—and equilibrium data for carbonyl sulfide. Girdler Catalysts, Chemical Products division Chemetron Corp.

Circle E2 green card, last page

Put Darlington insulation on . . .



. . . wherever waste heat comes off

In atomic power stations and oil refineries, in ships and schools and sealing wax plants, Darlington Insulation is cutting heat losses, reducing fuel consumption and saving money for industrial and commercial firms of all kinds.
With Darlington Insulation you can reduce your heat losses by up to 90%—and that means big savings on your fuel bill. Whatever your heat waste problem, there is a Darlington insulating material that can solve it. Why not ask our Technical Division for advice and assistance ? Simply write to :

THE CHEMICAL & INSULATING CO. LTD.
Darlington, Co. Durham
or telephone Darlington 3547
THE CHEMICAL & INSULATING CO. LTD. IS A MEMBER OF THE DARLINGTON GROUP OF COMPANIES

MH7

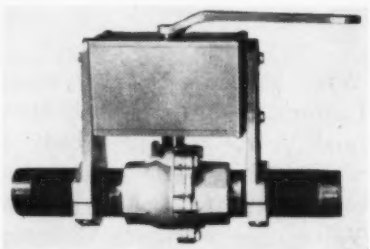
Pipe Hanger Puts End Stress Back In The Pipe

The problems of the high-temperature piping designer result from the fact that, using relatively rigid, thick-walled piping, he is asked to make connections between superheater or reheat headers and tubines, and at the same time produce limited stress reactions at the terminal connections. This is complicated by the fact that the piping, headers and turbine connections all move with increases and decreases in temperature. He gets some help in solving his problems by adding expansion bends to his systems to gain flexibility. On some installations the boiler designer helps by providing some flexibility at the header connections, but this help cannot always be used.

Flexibility designed into high temperature steam lines requires the use of considerable extra piping at costs which may run higher than $1,000 a foot. Fewer bends and more direct connections would result in considerable savings. Piping design engineers have long wished for some workable means of forcing the end stresses back into the piping where ample flexibility is available to take care of them.

The introduction of the Stress-Trol provides such a means. With this new device, the designer can control end reactions and concern himself only with the flexural stresses in the line itself. Grinnell Co., Inc.

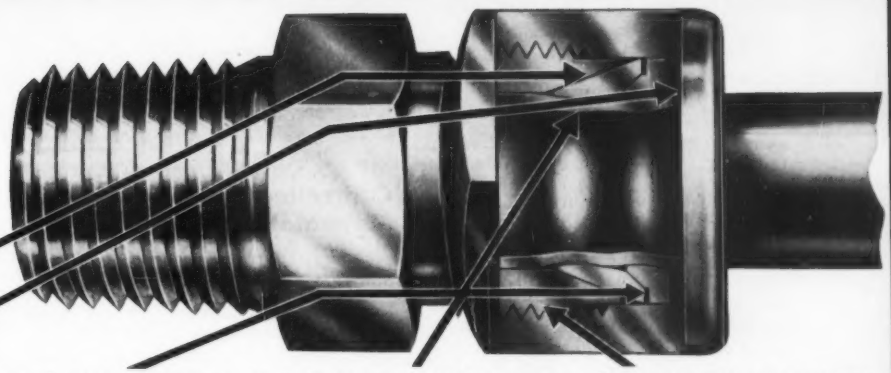
Circle E3 green card, last page



Electric Valve Actuator Fits Existing Valves

The R & A Electric Valve Actuator (mounted on a two inch ball valve, above) is a servo type mechanism for automatic operation of ball valves and other rotary stem type valves. It provides instant valve operation, no matter how remote or inaccessible the location. It is quickly and easily installed on existing valves, in any position, without disturbing any piping. It requires no

Here's what Swagelok has that's so good!



1. LEAKPROOF SEAL. Patented Swagelok design assures positive leakproof seals at 3 different contact points to hold extreme pressures and vacuums.

2. VIBRATION-FREE. Swagelok design enables fitting to firmly grasp tubing with two ferrules and a threaded chuck, assuring practical distribution of contact forces and maintaining vibration-free rigidity.

3. TORQUE-FREE. The positive 3-point sealing contacts in the Swagelok tube fitting attain top operating efficiency with only 1¼ turns of the tightening unit. Absolutely no torque is transmitted to the tubing in assembly.

4. CONSTRICTION-FREE. Because of the scientific distribution of the 3 leakproof contact points in the Swagelok design, there is practically no constriction of the inner tube wall, so that turbulence is negligible on heavy or thin wall tubing.

5. QUICK ADAPTABILITY. Swagelok tube fittings come to you completely assembled, finger tight, ready for immediate use. Simply slip the tubing into the Swagelok fitting, give the nut 1¼ turns, and the assembly is ready for assured, leakproof service.

In Swagelok tube fittings, there is nothing finer that man's ingenuity and precision machinery can produce.

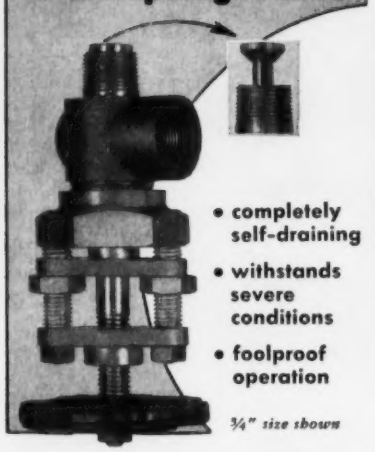
Swagelok is the one name that stands apart from all the others in the field... outstanding and unique in concept, craftsmanship and leakproof performance in extreme service.

Swagelok engineers are equipped with experience, ability, and wide range of tube fitting designs to meet your individual problems. Quick delivery of Swagelok tube fittings from local distributor stocks.

Swagelok® TUBE FITTINGS

CRAWFORD FITTING COMPANY
884 East 140th Street • Cleveland 10, Ohio
Crawford Fittings (Canada) Ltd., Stamford, Ontario, Canada

New!
Jerguson Drain or Sampling Valve



- completely self-draining
- withstands severe conditions
- foolproof operation

¾" size shown

The new Jerguson No. 23 Drain or Sampling Valve is completely self draining, for the valve stem seats on the outside of the valve body. It is ideal for installations where it is desirable to have the valve seat inside the wall of a vessel in order to prevent the typical condition of liquid remaining in the nipple and valve inlet.

This rugged, new Jerguson Valve has outside screw and yoke construction to meet high temperature or corrosive conditions where inside threads cannot be tolerated. The efficient outside thread design eliminates possible freezing and allows the valve stem to work freely at all times. The No. 23 Valve provides foolproof operation because the stem is constructed with a left-hand thread, thus allowing the valve handle to operate in the normal direction of standard valves.

Available in sizes from ¾" to 2" N.P.T. ¾" and 1" sizes are recommended for pressures of 4000 lbs. @ 100° F. and 1000 lbs. @ 750° F.; 1¼, 1½ and 2" sizes are recommended for 600 lbs. @ 100° F. and 250 lbs. @ 750° F. Optional features include construction with additional outlet for such uses as a steaming out connection and with a reamer on the end of the stem to break away encrusted matter which may have collected on the inside vessel wall.

Write for data unit and complete details.

JERGUSON

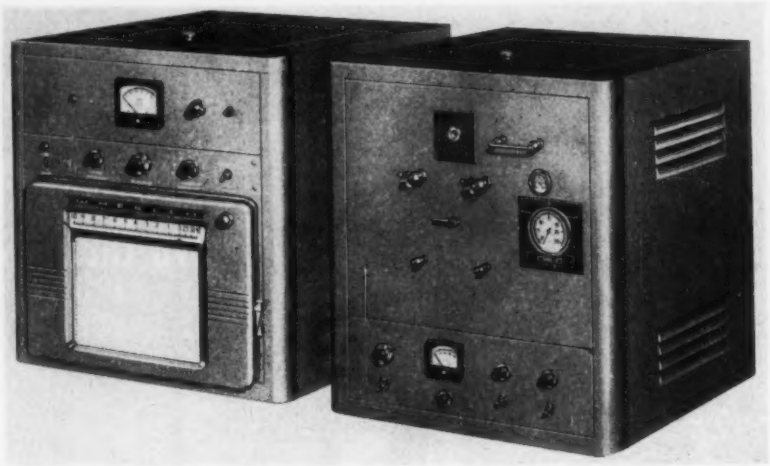
Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Adams Street, Burlington, Mass.
Offices in Major Cities
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

New Equipment . . .

air lines or air compressors and because it is explosion-proof, it can be used in hazardous locations. Available for ¼ to 8-inch valves, each model delivers many times the torque required to operate the valve for which it is rated. R & A Machine Co., Inc.

Circle E4 green card, last page



Portable Chromatograph for the Industry

Two basic sizes of gas-liquid chromatographic Ionization Detection Systems for automatic separation, indentification, and permanent recording of different chemical substances present in gaseous and liquid products at speeds and accuracies previously impossible, are available.

Being made available are the Model 10, a permanent-installation laboratory system capable of either single- or dual-column operation using glass, metal, or capillary columns, and the Model 20 (shown above) a portable system using capillary tubes. The latter is particularly designed to meet the needs of the petrochemical industry.

The new system measures ionization current initiated by a small radioactive source and guarantees accuracy superior to conventional devices which measure changes in thermal conductivity of a carrier gas stream contaminated with a sample vapor.

Greatly increased sensitivity results in significantly higher column efficiencies, permitting greater resolution of closely related substances. Smaller sample loads almost entirely eliminate the need for extraordinarily long columns to attain difficult separations. Barber-Colman Co.

Circle E5 green card, last page

Controller By-Pass Allows Manual Process Balancing

A new four-position Control By-Pass is offered as an option with the USG "Pilot" controller which can be used for control of temperature, pressure, liquid level and other process variables. Its prime function is to give the plant operator a ready means for cutting off controller air to the valve (or damper, etc.) and for positioning the valve manually. A plant may require such manual process control temporarily for these reasons:

- On process start-ups where the controlled variable (temperature, pressure, etc.) must be carefully raised to the automatic control point.
- When unusual process upsets required manual rebalancing of a process.
- When the controller must be adjusted, serviced, or removed to the repair shop.

The USG four-position Control By-Pass meets these requirements and also permits "bumpless" transfer from manual

These synthetic detergent storage tanks resist corrosion because they're made from Stainless Steel, USS 18-8, Type 304.

To safely store synthetic detergents, we turned to Stainless Steel

"We make synthetic detergent that is mildly corrosive to conventional metal tanks," says Mr. L. R. Henry, Maintenance Engineer at the Atlantic Refining Company "Ultrawet" Plant in Philadelphia. "We have tried other metals and sprayed-on coatings. In our experience, Stainless Steel tanks have given the best protection yet against corrosion and product color deterioration. We've had these Stainless tanks for more than four years without any corrosion problems. We expect them to last about three times as long as conventional tanks."

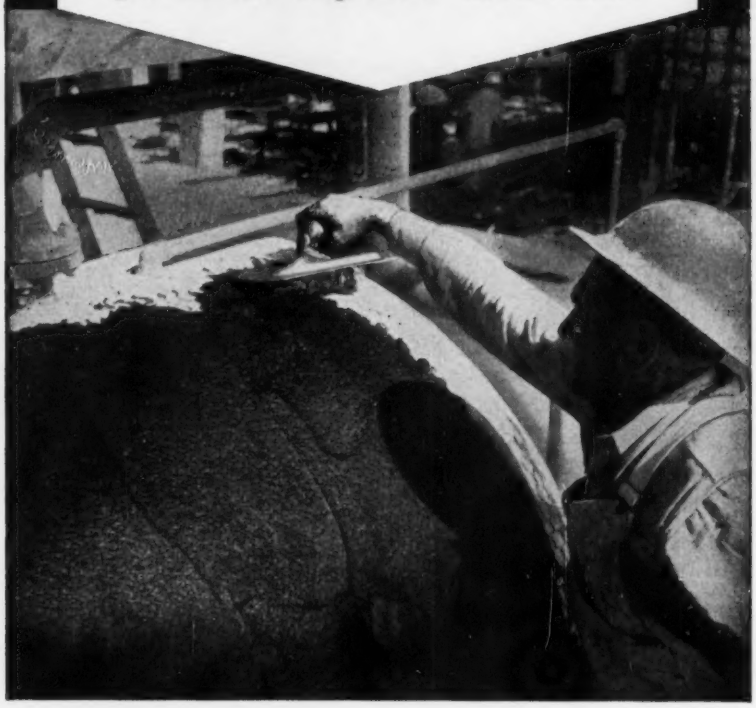
If corrosion has cut short the service life of your equipment, replace it with Stainless Steel. In the long run, it costs a lot less because Stainless Steel lasts a lot longer. And if you want to be positive of service-tested quality, specify USS Stainless Steel.

USS is a registered trademark

United States Steel Corporation—Pittsburgh
American Steel & Wire—Cleveland
National Tube—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

USS **United States Steel**

Laykold® WEATHERCOAT
protects exposed insulation



INSULATION on towers, tanks and exchangers must be kept DRY. If moisture gets through, the efficiency drops.

Modern refinery and plant design places many major insulated vessels "in the open." You can maintain the efficiency of your insulation with easy-to-apply Laykold Weathercoat.

Weathercoat is a fibrated asphalt-base material of easy troweling consistency that dries to a black, remarkably tough and tenacious coating. A majority of the leading refineries are regular users of Weathercoat.

A new product: Mastic Weathercoat, a bodied material, for use wherever economy demands the application of a *single*, thick layer.

Write today for free illustrated brochure, entitled "Laykold Weathercoat for Insulation Protection."

American Bitumuls & Asphalt Company

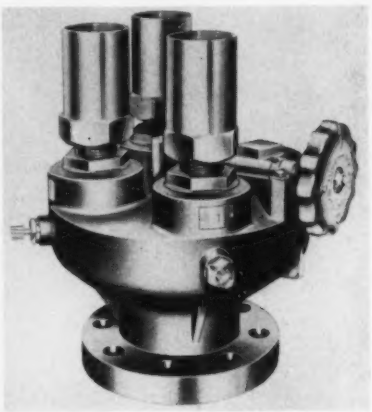
320 Market St., San Francisco 20, California

Baltimore 3, Md. · Mobile, Ala. · Inglewood, Calif. · St. Louis 17, Mo. · San Juan 23, P.R. · Oakland 1, Calif. · Perth Amboy, N. J. · Cincinnati 38, Ohio · Tucson, Ariz. · Portland 7, Ore.

New Equipment . . .

to automatic control. This means that when the transfer is made, the operator can match output air pressures from controller and manual regulator so that no difference exists to upset the process. U. S. Gauge, division of American Machine and Metals, Inc.

Circle E6 green card, last page

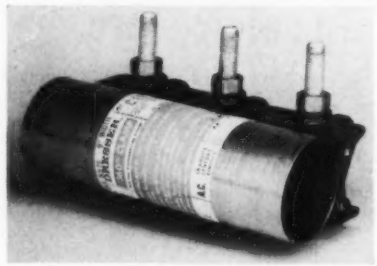


Three-Port Relief Valve Protects Ammonia Tanks

A new Three-Port Safety Relief Valve Manifold for NH_3 service provides positive protection against tank shutdowns necessitated by the periodic removal of relief valves for replacement or testing. The new RegO manifold makes it possible to remove any one of the three safety relief valves while the tank is under pressure. The remaining two valves provide ample safety relief capacity for even a 30,000-gallon anhydrous ammonia tank.

Any valve on the manifold can be easily removed after a revolving disc, which is manipulated by a large handwheel, is positioned under the safety relief valve. Numbers on the handwheel correspond to numbers for each safety relief valve and permit selection of any valve. The Bastian-Blessing Co.

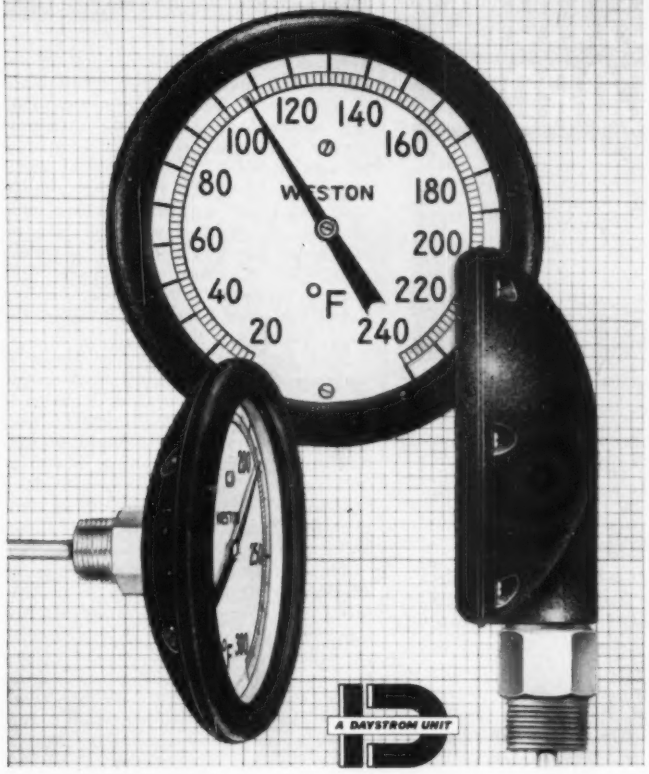
Circle E7 green card, last page



Pipe Repair Clamp Gives Positive Leakproof Seal

Here is a new small-diameter pipe repair clamp, the Dresser 2 and 3-inch "360" all-around Repair Clamp. Made of stainless steel and Grade A malleable iron lugs, these clamps provide an easier-

WESTON THERMOMETERS: STANDARDS OF STABILITY IN SCIENCE AND INDUSTRY



WESTON HEAVY-DUTY BIMETALS:

Proved under industry's most punishing conditions:

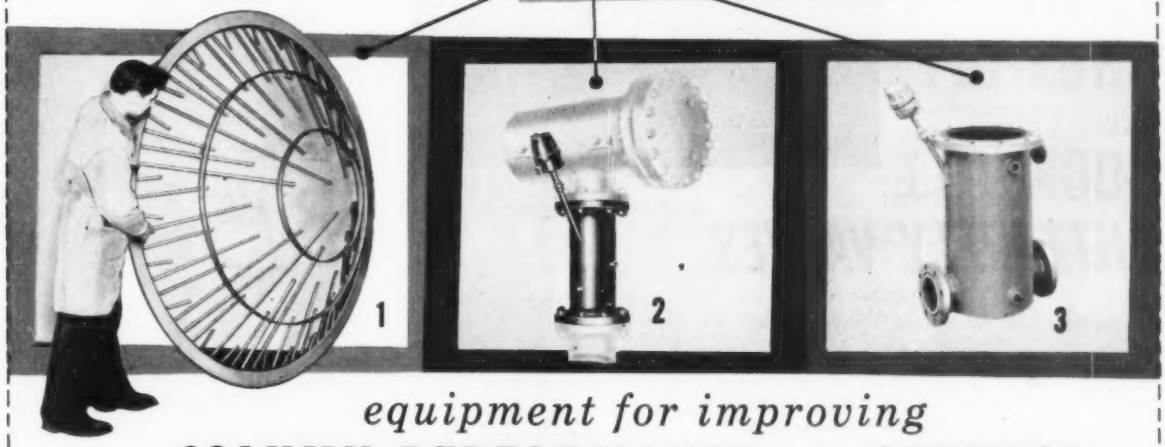
Wherever thermometry is critical or unusually demanding you can specify *Weston* with confidence. You have at your disposal a full line of the most rugged, stable, sensitive instruments ever designed for strenuous service.

Weston Heavy-Duty Bimetal Thermometers offer exceptionally reliable sensitive elements...corrosion-proof, pressure-tested stainless steel stems and connection nuts . . . abuse-proof forged brass heads . . . unusually large, readable scales. Accuracies within 1% of full scale range are assured. 20 standard ranges are available–covering an area from –100° to 1000° F. or –100° to 400° C. Standard stem lengths from 2½" to 72"; scale lengths of 9" and 12".

Catalog 09-100 contains full information. Contact your local Weston representative, or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

WESTON *Instruments*

DISTILLATION exclusives!



equipment for improving COLUMN PERFORMANCE *and* CONTROL

1. LARGE SIZE REDISTRIBUTOR: (now built in sizes up to 90") Collects and distributes liquid evenly over the packing, minimizes channeling and keeps packing wet and at maximum efficiency at all liquid rates. Especially suitable for vacuum distillation. Can be used with all types of packing and readily installed in any installation.

2. AUTOMATIC REFLUX HEAD: Explosion proof, electrically operated for high vacuum, pressure and temperature and for corrosive and hazardous service. Designed to handle both vapor and reflux at the top of distillation columns. Eliminate reflux control problems with its simple, accurate and dependable operation.

3. AUTOMATIC REFLUX SPLITTER: Similar to item #2 but designed for handling reflux only. Available as standard units with capacities up to 3000 gals. per hour. Larger and steam-jacketed units also available.

The above items are available in most materials of construction and in sizes 2" and larger.

ALSO AVAILABLE: Packing support plates, distributor plates, stills, columns, and complete distillation plants.

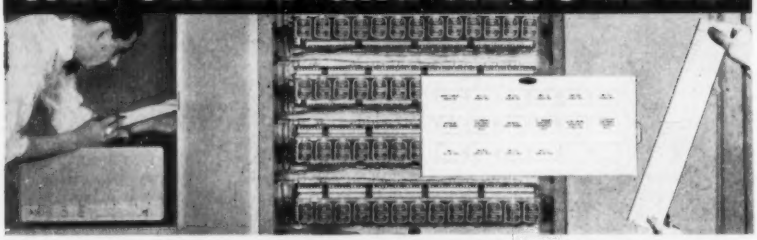
FURTHER INFORMATION AVAILABLE ON REQUEST

All items above are patented.

DISTILLATION ENGINEERING COMPANY 110 DORSA AVENUE, LIVINGSTON, N. J.

For more data on advertised products, use Readers' Service Cards, last page.

OFF-NORMAL CONDITIONS REPORTED and RECORDED



New PANALARM Recording Annunciator Helps Keep Operating Units on Stream, Uncovers Profit Leaks

- **Pinpoints refinery and pipeline trouble areas by accurately, instantly recording off-normal and on-off operations.**
- **Permanent, unalterable statistical data helps prevent down-time repetition.**
- **No time-wasting decoding. Directly readable digital form.**

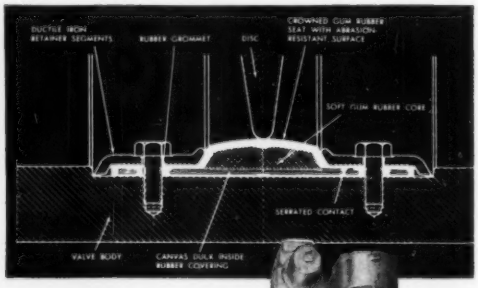
Model RA helps attain highest quality products by continuously monitoring all process variables. Also helps reduce downtime, maintenance and operating costs in your plant. Write for Bulletin 102 today.

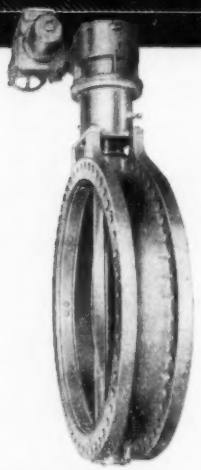
PANALARM

PANELLIT, INC.

7401 No. Hamlin Ave., Skokie, Ill.

DRIP-TIGHT SHUT-OFF *with* ROCKWELL *BUTTERFLY VALVES*





The matchless new "Wedge-Lock" rubber seating provides drip-tight shut-off in Rockwell Butterfly Valves. Its unique construction makes leak-proof closure sure and safe. Valves can be made with full rubber lining.

Other advantages—minimum restriction to flow, positive manual or automatic control, easier installation in less space, minimum maintenance.

Made in all sizes, in 25-, 50- and 125-lb. service in all industrial applications.

Write for Bulletin 582.

ROCKWELL SINCE 1888 BUILT

W. S. ROCKWELL COMPANY

Valves - Butterfly · Slide · Diaphragm · Special

2369 ELIOT STREET • FAIRFIELD, CONN.

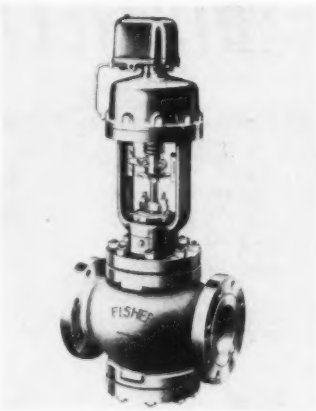
New Equipment . . .

to-install, more efficient method of repairing full breaks or holes in all kinds of pipe. Besides being a clamp, the "360" can be used as a coupling. Asbestos-cement pipe with broken ends can now be used with the "360" simply by evening the ends of the pipe and joining. Odd lengths of plain-end cast iron pipe can also be coupled with the lugs on only one side. This feature simplifies installation of these new clamps. Just remove the bolts from the lugs, spring the clamp around the pipe, re-insert the bolts and tighten the nuts.

This exclusive sliding lug design is maintained in the smaller sizes. A unique design eliminates all weak or loose parts and assures a positive, leakproof seal. Bolt pull is transmitted effectively into pressure, preventing pivoting action or bolt bending. The lugs also permit a range of adjustability sufficient to compensate for variations in asbestos-cement and cast iron pipe diameters.

These small diameter clamps utilize the efficient finger design gasket to provide positive sealing over a greater range of adjustability. Cemented in place, these specially compounded Grade 33 gaskets conform to the pipe, cushioning it from shock and movement to help prevent future pipe breaks. Dresser Manufacturing division, Dresser Industries, Inc.

Circle E8 green card, last page

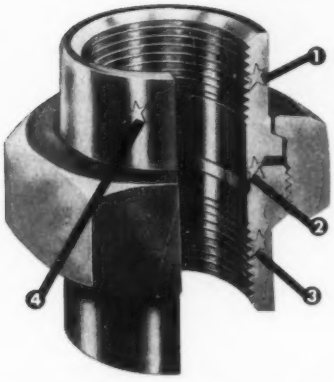


Pneumatic Valve Operator Works At High Speed

A new high pressure pneumatic piston operator, Type 470 POP, has been released. This equipment was designed primarily for applications where more force and higher stroking speeds are required than are available from diaphragm operators.

It includes an enclosed positioner mounted on the cylinder, suitable for a wide range of instrument signals. It operates on any supply pressure up to 150 psi, and creates stem forces from 1,500 to 12,000 pounds. Stroking speeds

only
CATAWISSA
gives you all these features for your forged steel pipe union requirements



1. Uniform walls for even expansion and contraction under temperature changes. They follow the pipe!

2. Catawissa Ball-to-Angle Seats give you a "Perfect Seal" regardless of pipe alignment!

3. More than adequate wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!

4. Round, straight barrels for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!

Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000 lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on modern, automatic machines with close inspection during and after production give you pipe unions second to none!

Write for Catalog 58 showing the complete Catawissa line of Perfect Seal Products.

for complete, guaranteed satisfaction

. . . always specify
CATAWISSA

CATAWISSA VALVE & FITTINGS CO.
CATAWISSA • PENNSYLVANIA

New Equipment . . .

range up to 1.5" per second.

The unit is easily reversible in the field and includes a weatherproof housing over the positioner and pressure gauges. Fisher Governor Co.

Circle E9 green card, last page

Chart Reader Records On Tapes Or Punch Cards

Recorded charts can now be read automatically quickly, and accurately. The Automatic Chart Reader eliminates time-consuming manual reduction. Strip or circular chart, film, or photographic traces are scanned optically by the basic reader. The basic reader produces a pulse-width modulated signal proportional to the ordinate of the trace as the chart drive moves the chart past the scanner. Optional accessary units convert this signal to digital, analog, or mechanical outputs. Optional computing units perform operations on the output such as scale change, integration, multiplication, reciprocal, etc.

Output may be stored on punched cards, punched tape, magnetic tape, or displayed on automatic printers. Nominal scan rate is 7,200 times per minute. Accuracy is ± 0.1 percent full scale. Chart speed depends upon resolution desired. An Automatic Chart Reader with computing and conversion units is shown in the photograph. The Geotechnical Corp.

Circle E10 green card, last page

Change Rust To Iron Phosphate For Painting

A four-page folder describes how Ospho, when applied directly to rusted metal, chemically changes rust to iron phosphate, stops metal oxidation and prepares the surface for regular maintenance paint. It also tells how the chemical provides a good bond between new metal and paint. Rusticide Products Co.

Circle E11 green card, last page

Water Additive Controls Cooling Water Algae Growth

A new cationic surface active agent, RD-2873-P, that displays excellent corrosion inhibiting bactericidal and foaming properties has just been developed.

The chemical is a 40 percent active isopropanol solution that is soluble in water, benzene, hexylene glycol and carbon tetrachloride. It has a pour point of less than 0 F.

The chemical effectively reduces cor-

Who needs super

FUEL

today?

Has the fuel-buying public turned up its noses at high octane? Not on your life. And more than 15 million high compression engines built in the last three years say they won't.

That's why refiners who are using the simple, flexible HOUDRIFORMING and ISO-PLUS HOUDRIFORMING processes can look forward to profitable high octane gasoline production for a long time to come.

Maximum yield of high octane fuels or aromatics and maximum economy of operation are the profit-making combination these processes provide. And with either process, the superior activity and stability of Houdry reforming catalyst also means lowest catalyst cost per barrel of throughput.

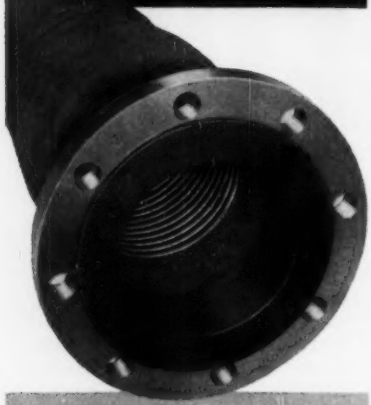
The reason for this profit-power in Houdry processes and catalysts is people. When you work with Houdry, you're getting the services of pioneers in catalytic processes. It's the close, careful, shirtsleeve-kind of service only possible when people all but eat, sleep and live catalysis. And the advantages are all yours.

*
HOUDRY
CATALYSTS
*Houdry means Progress . . . through Catalysis
HOUDRY PROCESS CORPORATION
1528 Walnut Street, Philadelphia 2, Pa.

CRUSHPROOF

LEAKPROOF

FLEXIBLE



STAINLESS STEEL LINED FOR VOLATILES...CHEMICALS

• Stands pressures up to 200 psi . . . rubber covered and leakproofed with special packing. Safe, sure protection for conveying the most volatile of chemicals and liquids without discoloration, contamination or corrosion. Ideal for handling solvents, special chemicals, high octane gasolines and jet fuels.

It is lighter in weight than any comparable competitive hose . . . easy to handle with swivel flange that allows installation in any position without turning entire hose to meet bolt holes. Available in sizes 2" to 12" I.D. Write for full details to Pennsylvania Flexible Metallic Tubing Co., Inc., 7207 Powers Lane, Philadelphia 42, Pa.

NEW BOOK

Gives complete technical details on flexible tubing. Free copy for you.

PENFLEX

TIGHT AS A PIPE BUT...

FLEXIBLE

New Equipment . . .

rosion of steel in water systems. Small additions of RD-2873-P to aerated solutions prevents rusting or etching of mild steel cylinders at room temperature, whereas specimens in untreated solutions become heavily rusted.

It effects nearly complete control of micro-organisms found in cooling water. Total growth inhibition in a mixed culture of algae was obtained with 0.01-0.02 percent of the chemical.

Aqueous solutions of the agent produce large quantities of stable foam. Hard water, high salt concentrations and varied solution temperatures show only slight effect on volume and stability of foam. Armour and Co., Chemical division.

Circle E12 green card, last page

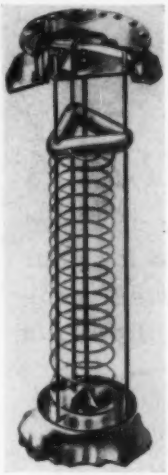
Bulletin Tells Gas Turbine Operating Experience

The new illustrated Bulletin 167 details operating experience with the Mark TA 750/1000 kw gas turbine. Salient design features, types of fuels (natural gas, distillate, crude oil) plus applications in process industries are thoroughly discussed. Also included is an assessment of the integrated turbine-boiler package and likely future trend in turbine application. Clark Bros. Co.

Circle E13 green card, last page

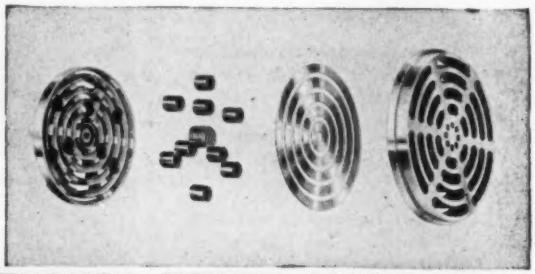
Gauge Measures Average Temperature In Tanks

The Type TR6 Tank Average Temperature Gauge is designed for the measurement of the average temperature of liquids in fixed or floating roof tanks within the range —100 C. The equipment, which is essentially a resistance thermometer, is suitable for operation in conjunction with any of the resolving methods usually applied to resistance thermometers.



The resistance element is a high temperature coefficient nickel wire, 120 feet long, which is wound in the form of a helical spring. The wire is inserted into a robust extendable nylon tube. The tube also contains additional insulated copper wires which form ballast weights to make the specific gravity of the resistance element nearly the same as that of the liquid to be measured. In effect, the resistance element becomes virtually weightless, and an evenly spaced distrobution of the turns of the spring throughout the liquid is

VOSS VALVES in your machine mean



LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

• up to 40% more valve area • minimum pressure loss • higher efficiency
• less power consumption • normal discharge temperature
• quiet, vibration-free • utmost safety • lower operating costs

VOSS VALVES are made to specification, machined from solid stock (not cast)—using best alloy steels; for corrosion condition—stainless steels, such as 410, 18-8 or non-ferrous alloys—monel, inconel, etc. PLATES are machined (not stamped) and ground for precise close tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. SPRINGS of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

J. H. H. VOSS VALVES REG U.S. PAT. OFF.

J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.

insured, thereby effecting a true average temperature measurement.

The equipment described is suitable for working depths between 30 and 60 feet and can be used with all liquids which are inert to nylon.

The designers have given particular attention to ease of installation, and no permanent fixture to the inside of the tank is required.

The resistance element and associated components meet the requirements of intrinsic safety, and when used in conjunction with suitable resolving methods, remote indication and switching for a common indicator in multiple installations, may form part of the circuit. Evershed and Vignoles Ltd.

Circle E14 green card, last page

Hand Operated Hot Tap Machine Has Dual Purpose

A new dual purpose tapping machine, the Model 100-C is available. The hand operated unit permits ½ to 2-inch hot taps through gate or plug valves into piping and tanks. Taps may be made on lines in service, pressures up to 1,440 psi at 100 F, or temperatures up to 700 F at 700 psi.

The machine is designed to install scraper passage indicators and to install and remove gauge adapters, thermometer wells, corrosion test coupons, etc., without shut down. A new gearing system permits the boring bar to be rotated without travel and extended without rotation.

Planetary gearing provides automatic drill feed, and a selective clutch provides a fast feed for advance and retraction, and a fine feed for cutting. Maximum boring bar travel is 18 inches. The machine weighs 44 pounds. T. D. Williamson, Inc.

Circle E15 green card, last page

Catalog Has Updated Data For SS Welding Fittings

Complete dimensional data on the full line of Tube-Turn stainless steel welding fittings and flanges is contained in a revised catalog, TT600.

Updated technical data for allowable S-valves, allowable working pressures of fittings, pressure-temperature rating of flanges and corrosion resistance are contained in the 54-page booklet. Corrections have been made to reflect recent code changes and to conform with new code interpretations for types 304L and 316L stainless steel.

Applications for stainless steel piping, welding procedures and Tube Turns' new program for packaging all of its stainless steel and non-ferrous alloy fittings and flanges are described in introductory sections of the catalog. Tube Turns.

Circle E16 green card, last page

Complete Hydrocarbon Data Shown In 137-Page Bulletin

The latest edition of "Phillips 66 Hydrocarbons and Sulfur Chemicals" has been released.

This 137-page bulletin gives complete specification properties of the many hydrocarbon products supplied by the company.

In addition to the new products now regularly available, the bulletin contains a list of certain other chemicals currently supplied in limited quantities but potentially available in larger volumes. Special Products division Phillips Petroleum Co.

Circle E17 green card, last page

Plastic Packing Material Helps Oxidized Liquid Waste

A 32-page bulletin about Dowpac, the company's new plastic packing material used in the biological oxidation of liquid wastes, is now complete.

The bulletin contains illustrated information on the product's physical properties, assembly instructions and operational characteristics.

Information also is given which explains the wide design latitude possible with Dowpac, and includes performance data gathered from a variety of pilot plant installations. The Dow Chemical Co.

Circle E18 green card, last page

Bulletin Has Mixer Selection Tables

A new bulletin on mixers and mixing discusses the theory of mixing and compares the range of operations of different types of mixing equipment.

The booklet also contains tables which assist the engineer in the selection of mixer size for any specific application, depending upon the degree of mixing required. The material is clearly divided into discussions of rapid mixing, slow mixing, i.e., blending and flocculating, and gas dispersing mechanical equipment. Infilco Inc.

Circle E19 green card, last page

O_2 analysis in

13 SECONDS

with the L&N Magnetic O_2 system

Now you can detect changes in O_2 concentration in 13 seconds . . . get data to your operator before combustion gases "see daylight."

And this O_2 system does something never done before: produces a continuously averaged sample which accurately represents combustion conditions . . . and does it *day after day.*

Such reliability is bringing an entirely new concept of "on the job" stamina to flue gas sampling and measurement. Already, these O_2 systems are in operation . . . some as automatic controllers.

Write for Folder ND46-91(5), Leeds & Northrup Co., 4923 Stenton Ave., Phila. 44, Pa.

LEEDS & NORTHRUP
Instruments — Automatic Controls • Furnaces

For more data on advertised products, use Readers' Service Cards, last page.

Advertisers in This Issue

PETROLEUM REFINER, FEBRUARY, 1959

*The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1959 Refinery Catalog.

A

ACF Industries, Inc. 191
Advertising Federation of America 214
*The Air Preheater Corp. 4
*Airetool Manufacturing Co. 228
Allied Chemical Corp. 12, 26
Allied Chemical—Nitrogen Division 180
*Allis-Chalmers 27
Alloy Steel Products Co. 91
Amercoat Corp. 60
American Bitumuls & Asphalt Co. 250
American Brake Shoe Co. 239
*The American Brass Co. 171
*American Bridge Division
United States Steel 178-179
American Car & Foundry Division
ACF Industries, Inc. 191
American Cyanamid Co.
Refinery Chemicals Department 97
American Petroleum Institute 70
American Steel & Wire Division
United States Steel 249
*The V. D. Anderson Co. 176
The Annin Co. 33
Austin-Western Works
Construction Equipment Division
Baldwin-Lima-Hamilton Corp. 210

B

The Babcock & Wilcox Co. 211
*Badger Manufacturing Co. 54
Baldwin-Lima-Hamilton Corp. 94, 210
*Barco Manufacturing Co. 222
*Barrett Manufacturing Co. 238b
Bethlehem Steel Co. 217
Betz Laboratories, Inc. 45
Bingham Pump Co. 62
*Black, Sivalls & Bryson, Inc. 185
*Blaw-Knox Co. 66
The Bristol Co. 186-187
*British Ermeto Corp. Ltd. 36-B
*Brown Fintube Co. 199
Budenberg Gauge Co. Ltd. 36Da
*Buell Engineering Co. 11

C

*Calumet & Hecla, Inc. 101
*Camco Fittings, Inc. 181
*The Cape Asbestos Co. Ltd. 39
*Carrier Corp. 74-75
Carter-Waters Corp. 232b
*Catawissa Valve & Fittings Co. 253a
The Chemical & Insulating Co., Ltd. 246
*Chemical Construction Corp. 105
Chiyoda Chemical Engineering &
Construction Co. Ltd. 220a
Classified Advertising 242
Columbia-Geneva Steel Division
United States Steel 249
*Cooper Alloy Corp. 215
*The Cooper-Bessemer Corp. 22-23
Corning Glass Works 76
Crane Co. 167
Crawford Fitting Co. 247
Crouse-Hinds Co. 6, 79-82

D

Darling Valve & Mfg. Co. 55
Davison Chemical Co.
Division W. R. Grace & Co. 34
Daystrom, Inc. 251a
Distillation Engineering Co. 251b
Dowell 172
E. I. du Pont de Nemours & Co. 14
Durabla Manufacturing Co. 226
The Duraloy Co. 221

E

*E. C. D. Limited 36-A
Eddystone Division
Baldwin-Lima-Hamilton Corp. 94
Electro-Alloys Division
American Brake Shoe Co. 239
*Elliott Co. 40-41, 230
Engelhard Industries, Inc. 50
*Enjay Co. 51
Ethyl Corp. 16-17

F

Fisher Governor Co. 212-213
The Foxboro Co. 48-49

G

Gardner-Denver Co. 232a
*The Garlock Packing Co. 107
Geigy Agricultural Chemicals 19
General Cable Corp. 224a
General Chemical Division
Allied Chemical Corp. 26
A. J. Gerrard & Co. 182
Gilbert & Barker Manufacturing Co. 224b
*Goulds Pumps, Inc. 83
W. R. Grace & Co. 34
*Graham Manufacturing Co. 32
*Graver Tank & Manufacturing Co. 229
*Grinnell Co. 78
*The Gulf Publishing Co. 36Db, 77

H

Harrisburg Steel Co.
Division Harsco Corp. 209
Harsco Corp. 209
*Heliflow Corp. 32
*Hendrick Manufacturing Co. 71
*Hills-McCanna Co. 67
Houdaille Industries, Inc. 208b
Houdry Process Corp. 253b
*Hudson Engineering Corp. 223
*Hydril Co. 63

I

*Ingersoll-Rand Co. 165
The International Nickel Co. 44, 169
International Petroleum Exposition 73

J

Jefferson Chemical Co. 28
*Jerguson Gage & Valve Co. 248

K

The M. W. Kellogg Co. 20, 183
The C. M. Kemp Mfg. Co. 65
Kerotest Manufacturing Co. 196
*Richard Klinger Ltd. 37
*Koch Engineering Co. 259
Koppers Co. 47
Koven Fabricators, Inc. 238a

L

Ladish Co. 69
Leeds & Northrup Co. 255
Lempe Hydraulic Pressing & Forging Co. 188
Linde Co.
Division Union Carbide Corp. 95
*The Lummus Co. 175

M

Manzel Division
Houdaille Industries, Inc. 208b
Metal Textile Corp.
Division General Cable Corp. 224a
*Midwest Piping Co. 98
Minneapolis-Honeywell 18, 202, 240-241
*Mixing Equipment Co. 85
*Samuel Moore & Co. 103
Mueller Co. 29

N

Nash & Thompson Ltd. 36-Ca
*National Airoil Burner Co. 234a
National Aluminate Corp. 59
National Tube Division
United States Steel 249
*New England Tank & Tower Co. 31
Newport News Shipbuilding & Dry Dock Co. 72
W. H. Nicholson & Co. 108
*Nooter Corp. 260
*Norton Co. 24

O

OPW Corporation 84
*Oakite Products, Inc. 99
Oceanways Trading Corp. 243b
Orbit Valve Co. 184

P

Panellit, Inc. 252a
*Parker-Hannifin Corp.
Parker Fittings & Hose Division 64
Pennsylvania Flexible Metallic Tubing Co. 254a
*Petreco Division
Petrolite Corp. 102
*Petrolite Corp. 43, 102
*The Pfaudler Co. 236-237
Pittsburgh Corning Corp. 86-87
The Wm. Powell Co. 96
J. F. Pritchard & Co. 89
Procon Inc. 90

R

*The Refinery Catalog 56-57
The Ridge Tool Co. 220b
W. S. Rockwell Co. 252b
*Rockwell Manufacturing Co. 42
Rome Cable Corp. 8

S

Sachse Electric Inc. 234b
*Sarco Co. 68
*Schutte & Koerting Co. 30
*Selas Corporation of America 227
Shand & Jurs Co. 93
Snap-Tite, Inc. 61
Solar Aircraft Co. 21
Solar Chicago
Division U. S. Industries, Inc. 189
Solvay Process Division
Allied Chemical Corp. 12
Southwestern Industrial Electronics Co. 208a
Standard Oil Co. (New Jersey) 92
Stauffer Chemical Co. 58
Stone & Webster Engineering Corp. 35
*Sun Shipbuilding & Dry Dock Co. 36

T

*Taylor Instrument Companies 88
Tennessee Coal & Iron Division
United States Steel 249
*The Terry Steam Turbine Co. 100
Trane Co. 231
*Tretolite Co.
Division Petrolite Corp. 43
*Triangle Valve Co. Ltd. 38

U

U. S. Industries, Inc. 189
Union Carbide Corp. 95
United States Gasket Co. 173
United States Rubber Co. 190
United States Steel Corp. 178-179, 233, 249
United States Steel Export Co. 249
United States Steel Supply Division
United States Steel 249
*Universal Atlas Cement Division
United States Steel 233
Universal Oil Products Co. 52-53

V

*Henry Vogt Machine Co. 46
*Vokes Genspring Ltd. 36Cb
*J. H. H. Voss Co. 254b

W

Walworth Co. 245
Warren Petroleum Corp. 192
Wedgeplug Valve Co. 177
Western Supply Co. 106
Westinghouse Electric Corp. 218-219
Weston Instruments
Division Daystrom, Inc. 251a
*Thomas C. Wilson, Inc. 243c
*Wolverine Tube Division
Calumet & Hecla, Inc. 101
Wright-Austin Co. 243a

Y

*Yarnall-Waring Co. 2
*Otto H. York Co. 25
*Yuba Consolidated Industries, Inc. 104

Z

*Zallea Brothers 235

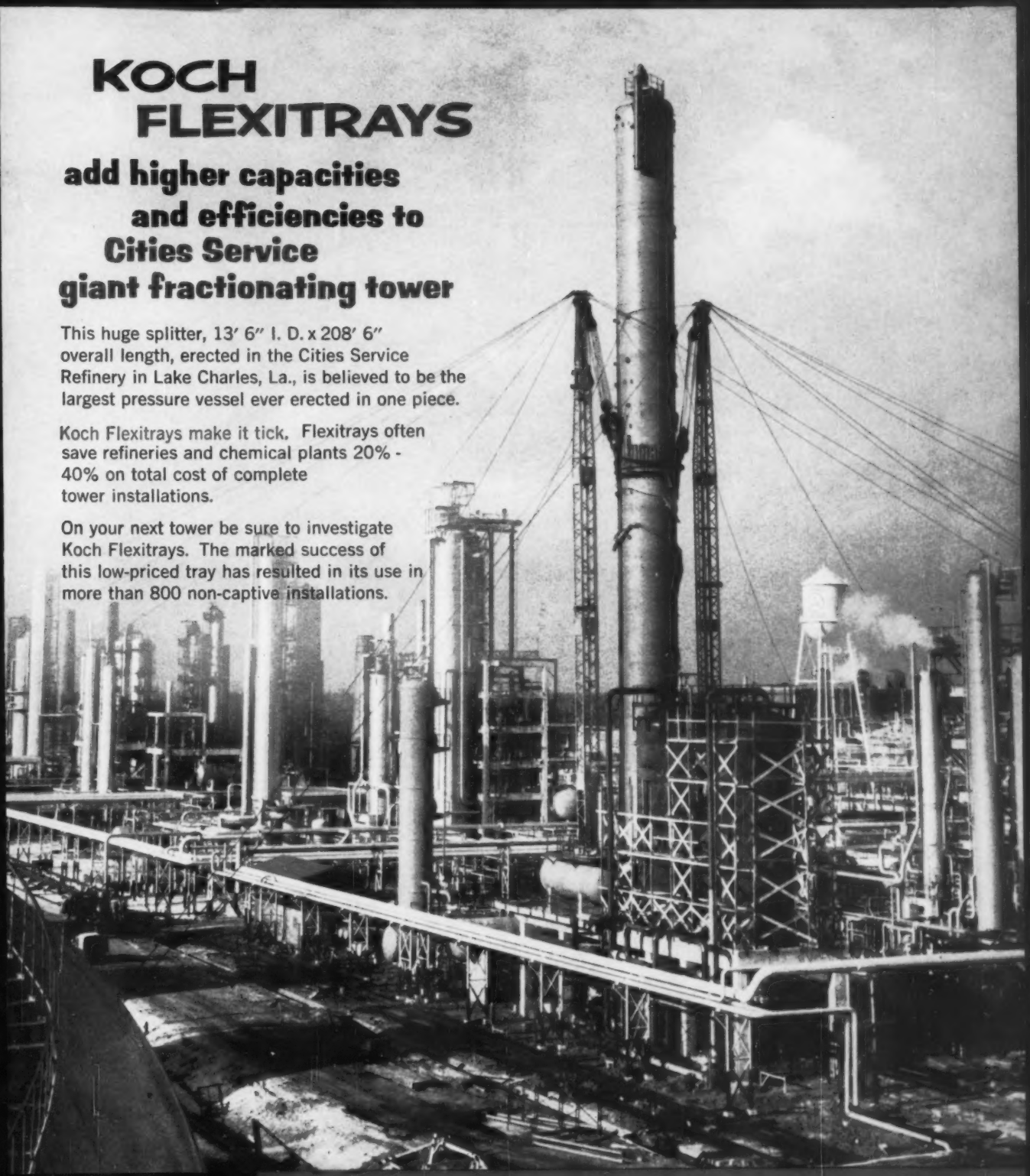
KOCH FLEXITRAYS

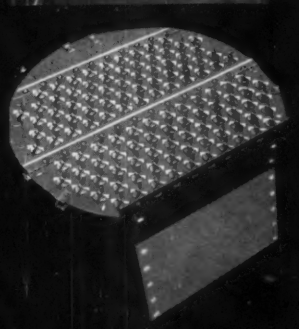
add higher capacities and efficiencies to Cities Service giant fractionating tower

This huge splitter, 13′ 6″ I. D. x 208′ 6″ overall length, erected in the Cities Service Refinery in Lake Charles, La., is believed to be the largest pressure vessel ever erected in one piece.

Koch Flexitrays make it tick. Flexitrays often save refineries and chemical plants 20% - 40% on total cost of complete tower installations.

On your next tower be sure to investigate Koch Flexitrays. The marked success of this low-priced tray has resulted in its use in more than 800 non-captive installations.





Contact your nearest Koch Representative, or write direct to...

KOCH

ENGINEERING COMPANY, INC.

321 West Douglas Avenue, Wichita 2, Kansas

Continuing progress through research

REPRESENTATIVES

BUTTE, MONTANA — G. M. Wallace & Co., P. O. Box 208
DENVER, COLORADO — G. M. Wallace & Co., 324 Denham Bldg.
EL PASO, TEXAS — G. M. Wallace & Co., Suite 511, Electric Bldg.
HOUSTON, TEXAS — Alpha Engineering Co., P. O. Box 12271
KANSAS CITY 12, MISSOURI — Semple Brothers, P. O. Box 7063
NEW YORK 17, N. Y. — F. J. McConnell Co., 60 East Forty-Second St.
OAKLAND, CALIFORNIA — Engineered Process Equip. Co., 600 Sixteenth St.
PARK RIDGE, ILLINOIS — M. B. Fisher, 1521 Courtland Ave.
PASADENA, CALIFORNIA — Engineered Process Equip. Co., 774 East Green St.
PITTSBURGH 19, PENNSYLVANIA — D. D. Foster Company, 2210 Koppers Bldg.
SALT LAKE CITY, UTAH — G. M. Wallace & Co., Continental Bank Bldg.
SOUTH CHARLESTON, WEST VIRGINIA — D. D. Foster Co., 411 "Z" St.
ST. LOUIS 17, MISSOURI — Semple Brothers, 2010 Big Bend Blvd.
TULSA, OKLAHOMA — H. C. Myers Co., Wright Building

NOOTER

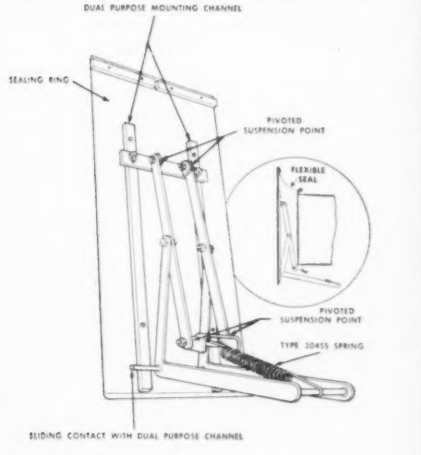
FLOATING ROOF TANKS

Offer You

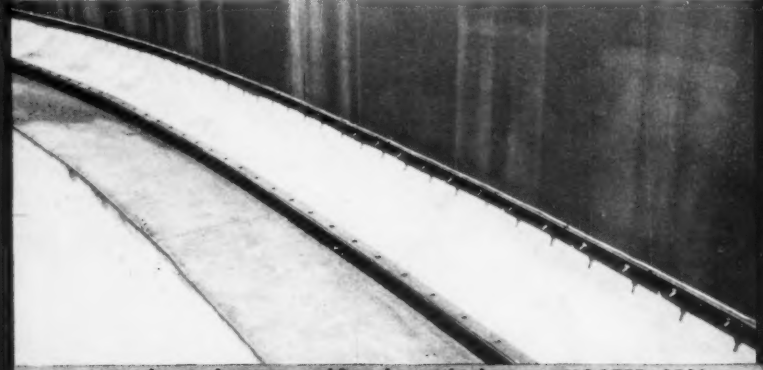
MAXIMUM
SEAL PROTECTION
MINIMUM
MAINTENANCE

NOOTER is fully experienced in the fabrication and erection of double deck, pontoon and pan type floating roofs—all with the patented Nooter Seal. The Nooter design means better protection for your product because of the more efficient seal . . . minimum maintenance because there is no direct contact with the sealing ring, therefore minimum wear . . . and minimum delay in construction because easier installation and alignment are made possible by the new seal design. These advantages mean a better floating roof tank at a lower cost.

This Patented NOOTER SEAL HANGER is One Reason Why!



This exclusive Nooter 2-Point suspension seal hanger has one pivoted and one sliding point of contact with the dual-purpose mounting channel. This channel serves (1) as a means of attaching seal hanger to shoe without direct contact of seal hanger to shoe, and (2) as a method of providing even distribution of the forces of seal hanger over entire height of shoe.



you can also update your old tanks with the new NOOTER SEAL

The Nooter Seal is readily adaptable to any existing welded or riveted tank. Requires minimum modifications for fast, easy installation.

For your next floating roof tank, or seal replacement, send your inquiries to Nooter. You'll find Nooter quality and dependable deliveries your best equipment investment.

Catalog 158 on Nooter Floating Roof Tanks is yours for the asking.

NOOTER CORPORATION

"Since 1896"

Steel and Alloy Plate Fabricators and Erectors..."Boilermakers"

1404 SO. SECOND ST. • ST. LOUIS 4, MO.